GIGABYTE AORUS RADEON RX 570
Gaming on a budget PG. 78

HP Z2 MINI G3
The tiny workstation packing serious power PG. 80

INTEL OPTANE 32GB
Our first look at the new kind of memory PG. 85

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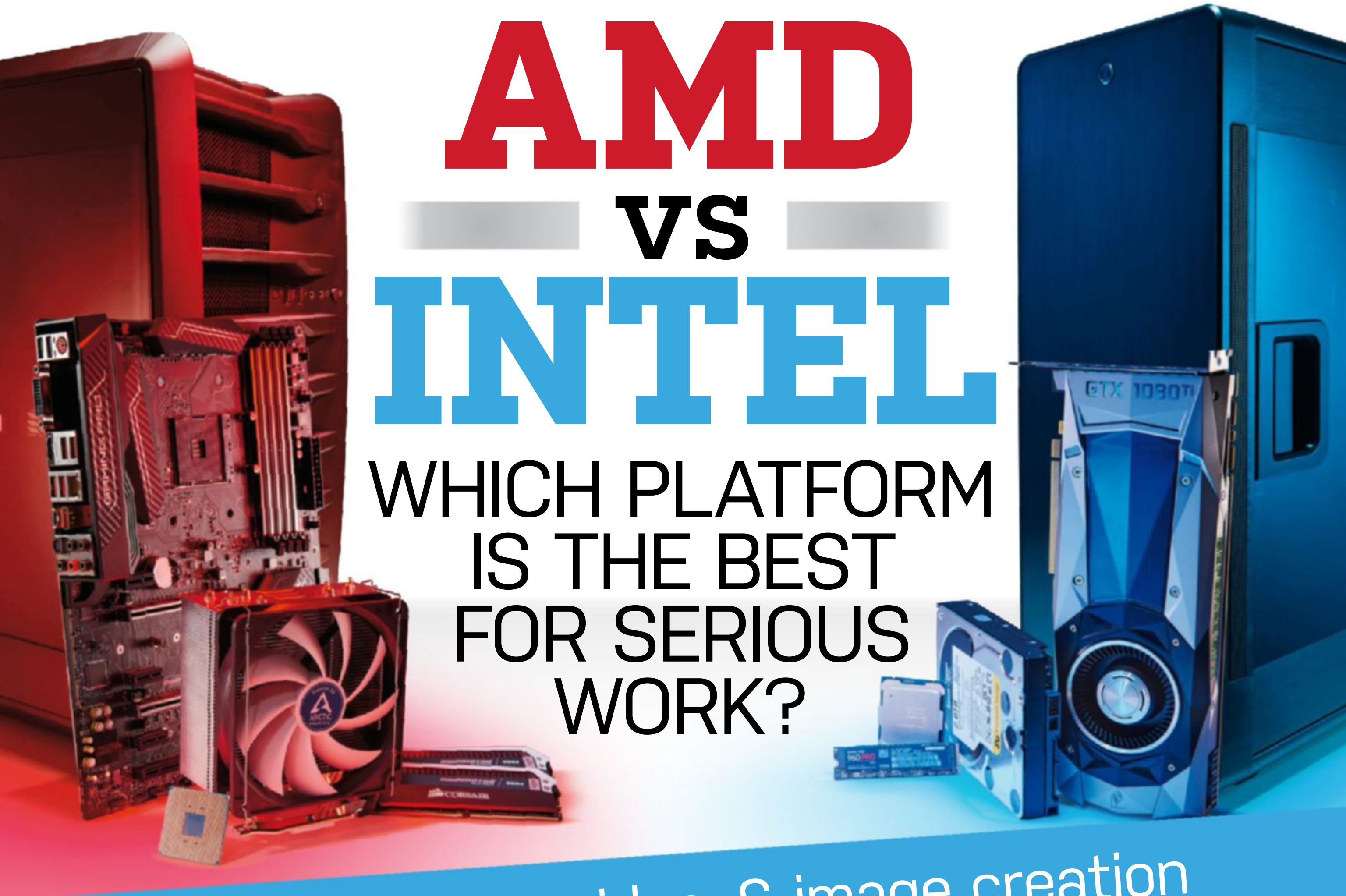

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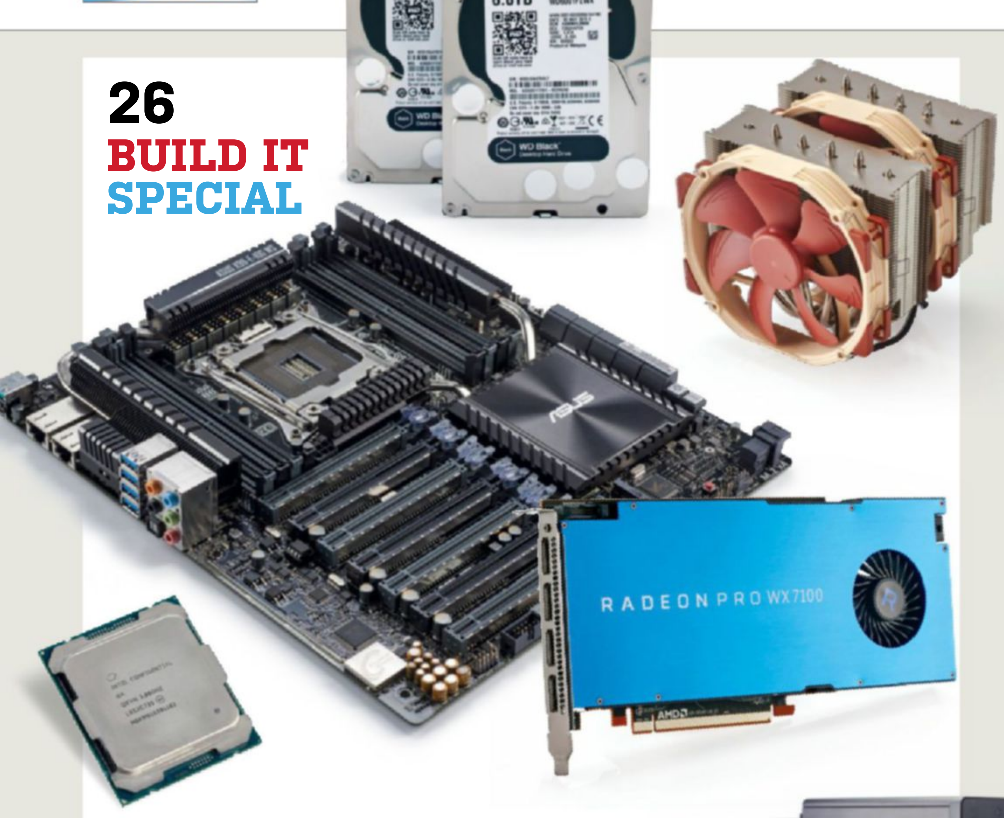

26
BUILD IT SPECIAL

QUICKSTART

12 THE NEWS
Windows S; new top-end processors; Daydream 2.0.

18 THE LIST
Maximum PC's selection of Microsoft hardware misfires.

The MS sunny-side-up trackball.

R&D

52 AUTOPSY
The Samsung Galaxy S8+ gets the full iFixit teardown treatment.

54 HOW TO
Advanced Kodi tips; play with 3D modeling clay; create bokeh effects; VR games on your cell.

66 BUILD IT
Our AMD and Intel workstations fight mano-a-mano.

26 BUILD IT SPECIAL
It's AMD versus Intel as two very different systems go head to head in our workstation showdown.

38 SET UP THE PERFECT NETWORK
Upgrade, optimize, secure, and troubleshoot your home network.

LETTERS

22 DOCTOR
94 COMMENTS

IN THE LAB

80 HP Z2 MINI G3

86 AOC AGON AG251FZ

85 INTEL OPTANE M.2 32GB PCIE 3.0 X2 NVME CACHE

90 YOOKA-LAYLEE

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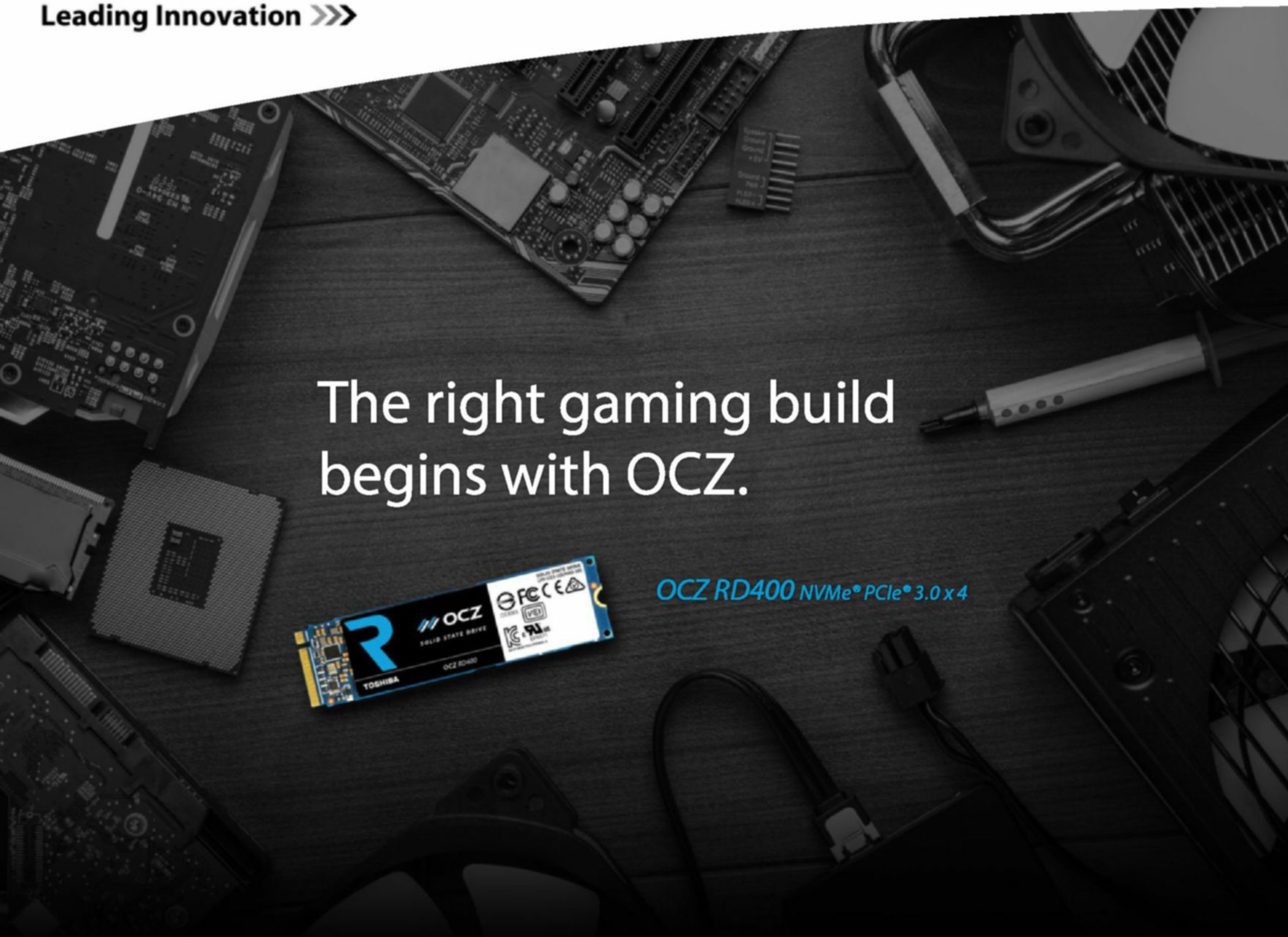

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Tuan Nguyen

TRADING PUNCHES

IF I HAD TO PICK A GOOD TIME to build a computer system, today is likely better than any day in the past 10 years. That's not to say that things haven't been exciting in the last decade—sure, we've gotten lots of products. But what makes today special is the fact that I believe AMD and Intel are on a path to collide.

Intel has had many missteps over the last few years. It may not seem that way if you're only looking at the desktop space, but in other tech areas, Intel has lost to other companies. Qualcomm sits comfortably on its mobile chip throne, and Nvidia is making great strides in AI and big computing. For such a giant company as Intel, it's a painful reminder that staying at the top is harder than getting there.

AMD hasn't been idly watching all these years. For the value-end market, Intel left a big hole, where AMD has successfully gnawed away piece by piece. As of today, the respective focuses of Intel and AMD on the desktop space are changing places: Intel wants to get at the value market, while AMD wants to tackle the high-end straight on.

Take Intel's new Core i9 desktop chip, for example: It's the first new line of CPUs from Intel in years, and one that's not entirely based on a new architecture. Think Core i7 Extreme Edition repackaged, renamed, and repositioned as a response to AMD's Ryzen 9 processor. This, to me, is profound, because the last time AMD provoked such an obvious response from Intel was with the original Athlon.

Our benchmarks show that Ryzen can dance with the best that Intel has to offer, and deliver that kind of performance at a much lower price point. Sure, there are cases where Ryzen will be slower in benchmarks than the equivalent Core CPU from Intel, but the two companies trade punches on an even level. The fact that Intel is rebranding an Extreme Edition processor to even the playing field with AMD is significant by any measure.

So, why is now the best time to be a builder? Choices. Real choices. I can go out there and confidently put my money down on an AMD system, and not have to think twice about performance issues. What I do have to look at, though, is full support from motherboard companies. I want my Ryzen motherboard to deliver the same feature set as any top-end Intel part, and manufacturers can take that as a call to action.

So, here's what I'd recommend for AMD: Go ahead and chase after the high-end market. But whatever you do, don't ignore the real estate you've carved out for yourself in the value segment. Learn from your rival's mistakes.

And here's what I recommend for the PC builder: Go ahead and vote with your wallet. I don't have to point you in any direction. You'll get a winning system from either camp.

Tuan Nguyen is Maximum PC*'s editor-in-chief, also known as "the pointy end of the stick." He's been writing, marketing, and raising hell in the tech industry for 20 years.*

↘ submit your questions to: comments@maximumpc.com

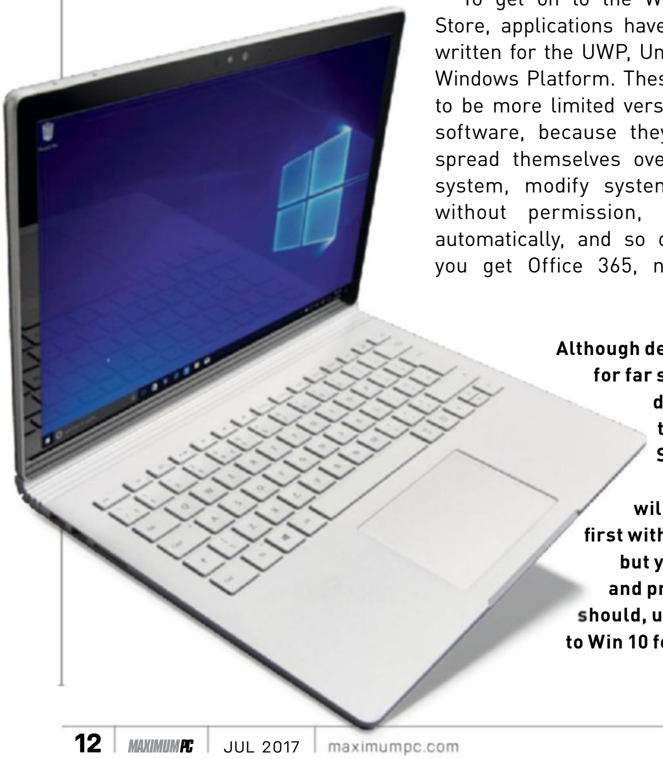
THE NEWS

Windows S Takes on Chrome OS

Microsoft's new cut-down OS debuts on Surface Laptop

BE HONEST NOW, did you think Google's Chrome OS would be a success when it arrived in 2011? A Linux-based OS designed around a browser, a bit too taxing for phones, and too limited on laptops. Even so, second-gen Chromebooks achieved decent sales, and now it's a success in one large and important sector of the market: education. Students have flocked to cheap and cheerful $200 Chromebooks.

Microsoft has cooked up a response with Windows S. What is the "S" for? Well, officially it doesn't stand for anything, but the blurb repeatedly states that Windows S is streamlined for security and superior performance. Student and store are more apt. "Streamlined" is, of course, another word for simplified. It's designed to be simple to use, employ cloud-based file storage, run on more basic levels of hardware, and have low power consumption. Essentially the same territory as Chrome. It looks and feels like Windows 10, but all your applications come from the Windows Store.



Although designed for far simpler devices, the new Surface Laptop will be the first with Win S, but you can, and probably should, upgrade to Win 10 for free.

To get on to the Windows Store, applications have to be written for the UWP, Universal Windows Platform. These tend to be more limited versions of software, because they can't spread themselves over your system, modify system files without permission, launch automatically, and so on. So, you get Office 365, not the full-fat Office 2016, Photoshop Express, not Photoshop, and so forth. Windows S can run any browser, in theory, but for now it just has Microsoft Edge.

Developers can bundle their Windows applications into a secure container for the Windows Store, but uptake has been slow. Giving Microsoft a cut of the revenue has been one stumbling point. At least using UWP means that security is tight, and your system shouldn't bloat and get sluggish, which is the curse of a "regular" Windows installation.

We've been here before, of course. Remember Windows RT, also from 2011? This version of Windows 8 was built for ARM processors, and was also limited to approved Windows Store applications. It died rather quickly, and cost Microsoft millions.

The first hardware to run Windows S is the new Surface Laptop, although you can upgrade to Win 10 Pro for free before the end of the year, or pay $49 after that. This sleek, lightweight machine has a 13.5-inch touchscreen with 2256x1504 display. Connectivity isn't extensive—basically, a USB 3.0 port, headphones jack, and a mini DisplayPort. It is a pretty straightforward laptop design, albeit a classy one in four colors. The fabric-covered keyboard is something of an oddity. The Alcantara material is coated, and should wipe clean, says Microsoft.

Prices start at $999 for a Core i5, with 4GB of memory, and a 128GB SSD, and run to $2,199 for a Core i7, with 16GB of memory, and 512GB of storage. If you want the rather fetching mouse that appears in many of the illustrations, it's an extra $79. This is clearly not the kind of hardware Windows S was designed for. More suitable Windows S devices starting at $189 are due this summer from the usual hardware players.

It is unfair to be too critical before we've even sampled Windows S properly, but it's obvious that we a have problem here. It's called Windows, and that brings the expectation that you can run Windows software. The Windows Store has improved, but it still offers only a small subset of the software out there, and lacks many popular and powerful packages. A Windows S machine can leave you feeling like you're stuck in a tiny sandbox in the middle of an amusement park.

Microsoft has made numerous attempts to move its OS on to smaller, more mobile devices, and none have succeeded. Windows S goes against a popular and well-proven OS with a huge installed user base. It is going to be a tough sell. **–CL**

Windows 10

AMD

AMD RADEON GRAPHICS

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NEW TOP-END PROCESSORS THIS SUMMER

AMD and Intel go to 9

SINCE THE LAUNCH of Ryzen, we've seen a hectic round of new processors, and it shows no sign of slowing this year. Both Intel and AMD have new top-end silicon on the way, and both have turned things up to 9.

As expected, Intel has brought forward its release schedule. A leaked internal slide is revealing (if you are serious about security, guys, you need to confiscate phones). There is a pair of four-core Kaby Lake-X chips, branded i7-7740K and i7-7640K, running at 4.3 and 4.0GHz. And four new Skylake-X chips move to the new Core i9 moniker: There's a six-core i9-7800X, eight-core i9-7820X, 10-core i9-7900X, and, at the top of the tree, a 12-core i9-7920X. Base clock speeds start at 3.3GHz and run to 3.6GHz. Boost speeds on all run at over 4.0GHz, up to 4.5GHz Turbo 3.0 (single-core) on the 7920X. Yikes. All run on new LGA-2066 boards with X299 chipsets. We should have all the new Core i7s to play with by the time you read this. The Core i9s are expected in August.

Meanwhile, AMD has its fancifully named Threadripper chips, the Ryzen 9. There are nine new versions in all. Base clock speeds are all fairly similar, running from 3.0 to 3.7GHz, with a 400–600MHz or so of boost, depending on which "leak" you believe. As expected, it's all about the cores—we get either 10 cores in the 1955 and 1955X, 12 cores in the 1956, 1956X, and 1976, 14 cores in the 1977 and 1977X, or a whopping 16 cores in the 1998 and 1998X. All get 44 PCIe lanes and quad-channel memory. Essentially, Ryzen 9 is two Ryzen 7 cores in one package. It'll use a modified SP3 socket with 4,096 pins (whoa!), developed for AMD's Naples server chips.

No pricing yet, but if things stay true to form, we can expect those juicy i9s to be expensive, and the Ryzen 9s to be competitive. Looks like the boys in the labs will have more heavy rounds of system testing to do very shortly. **–CL**

DAYDREAM 2.0 GOES WIRE-FREE

VR WITH NOTHING ADDED

GOOGLE'S FORTHCOMING DAYDREAM 2.0 will include a full stand-alone headset—no phone, no wires, nothing else required. The WorldSense tracking system uses motion detectors working with two wide-angle cameras, which use your physical surroundings as reference points. Google promises "robust low-latency tracking for games."

The headset runs Android O. You can take snapshots and videos as you go, as well as Chromecast to a compatible screen, so friends can see what made you squeal. Chrome VR adds 3D browsing, and YouTube VR brings shared "rooms" for your real virtual friends.

A reference design that uses a Snapdragon 835 chip is being developed with Qualcomm. HTC, Vive, and Lenovo are working on retail headsets, which should be here "within months." It all sounds rather neat. VR is struggling to get beyond the curious and the hardcore gamer; but Google has a knack of making things mainstream that were previously niche. **–CL**

HUGE WORLDWIDE RANSOMWARE ATTACK

NSA code powers WannaCry

ON MAY 12, WannaCry infected around 200,000 machines in the largest ransomware attack to date. Through a vulnerability in the Server Message Block, WannaCry sent a worm through infected systems, scrambling files, before demanding $300 in Bitcoins. It used two vulnerabilities, EternalBlue and DoublePulsar, which had been stolen from the National Security Agency. Win 7 PCs without the latest patch (issued on March 14) took 98 percent of the hits.

Once the panic died down, the end results proved mundane. Under $100,000 in Bitcoin was paid out. A nebulous group of hackers, the Lazarus Group, with probable links to North Korea, had been cited as a possible culprit, although only through similarities in the code. What did we learn? Well, as Microsoft's president, Brad Smith, points out, the NSA needs to take some responsibility here. It finds, researches, and develops hacking tools, many of which it then stockpiles. He equates the loss of the exploits from the NSA to the US Army having some of its Tomahawk missiles stolen. He has a point. **–CL**

Tech Triumphs and Tragedies

A monthly snapshot of what's good and bad in tech

TRIUMPHS

✓ **BITCOIN HITS $2,000**
The digital currency has doubled in value in under a year, a long way from 2010's value of 0.003 cents.

✓ **BLACKBERRY IS BACK**
Miss those little buttons? The new BlackBerry KEYone is a full Android smartphone with mini keyboard—excellent, but $549.

✓ **FLYING CARS**
Design sketches for a flying car to be used in the 2020 Tokyo Olympics opening ceremony look like giant drones you can sit in.

TRAGEDIES

✗ **LAPTOPS WITH KEYLOGGER**
HP has accidentally sold laptops with keylogger software embedded in the audio drivers, which could be used maliciously.

✗ **APPLE VS. REPAIRMEN**
Apple is busy lobbying against any legislation concerning the right to repair hardware, especially New York's Fair Repair Act.

✗ **NO NEUTRALS**
The FFC is dismantling net neutrality, despite the efforts of its head to frustrate the process.

Jarred Walton

TECH TALK

RIP IDF: The End of an Era

AFTER 20 YEARS, Intel has announced that it will no longer be holding its yearly Intel Developer Forum (IDF) conferences—both the San Francisco and Asia locations for 2017 have been axed. IDF has been one of the few constants for PC enthusiasts, and we've come to count on the regular updates and insights into Intel's future roadmaps.

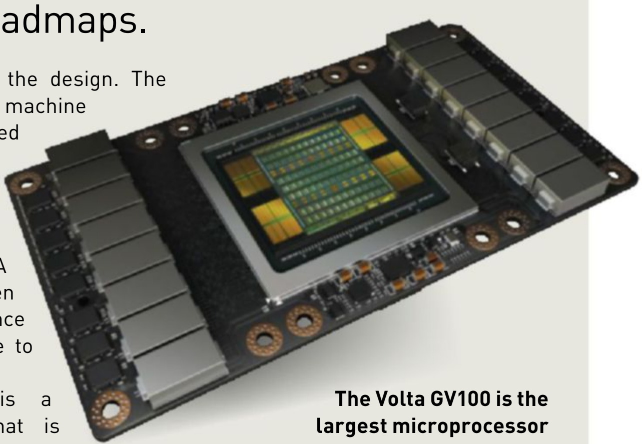
Reactions have ranged from the expected shock and disappointment, to an indifferent shrug. There are many reasons to ditch the yearly conference, and the last two IDFs have been weird hodgepodges of IoT and mobile talk that never seems to go anywhere, mixed in with a few presentations on new processors and fabrication technologies. As an example, two years ago, everyone at IDF got a Basis Peak smartwatch, which was later recalled due to overheating/burn problems that couldn't be fixed. Oops.

But as IDF closes its doors, Nvidia's yearly GPU Technology Conference (GTC) is becoming increasingly important. GPUs are outpacing the growth of other processors, and they happen to be extremely useful for one of the hottest research areas: machine learning and AI. SkyNet fearmongers will want to turn the page now, as there's apparently no stopping the advance of our AI overlords.

Last GTC, Nvidia revealed its first Pascal GPU, the GP100. It remains the most powerful GPU on the planet, boasting up to 25 TFLOPS of FP16 performance, with 16GB of HBM2 memory. Machine learning often distills down to doing massive amounts of matrix multiplication, a task for which GPUs are especially useful, and every major cloud service now offers VMs with Nvidia GPUs. Nearly every supercomputer in the Top500 list also includes GPUs, or similar technology, such as Xeon Phi.

This GTC, Nvidia unveiled its first Volta GPU, the GV100, a complete overhaul of previous designs. Nvidia has reworked the core layout, memory controllers, thread scheduling and execution, and other aspects of the design. The compute and machine learning focused GV100 also includes a new Tensor Core type that supplements the existing CUDA cores. Expect even better performance per clock relative to Pascal, basically.

> The last two IDFs have been hodgepodges of IoT and mobile talk that never goes anywhere.



The Volta GV100 is the largest microprocessor ever manufactured, measuring 815mm^2.

The GV100 is a massive chip that is likely never to find its way into a consumer GeForce product—the same happened with GP100. The full GV100 chip has 84 SMs with 64 CUDA cores each, giving it up to 5,376 CUDA cores, though four SMs are disabled on the Tesla V100, likely for yield considerations. That's still 30 percent more than GP100; so at least 30 percent better performance. The chip is also 30 percent larger, weighing in as the heavyweight champion of the GPU world. Another reason not to expect it to show up in consumer cards.

As for the new Tensor Core, it's a more densely packed but slightly less flexible core that works on data in 4x4 matrices. Each Tensor Core can do fused multiply add (FMA) operations on FP16 4x4 matrices. There are eight Tensor Cores per SM, 80 SMs in the Tesla V100, and a peak clock speed of 1,455MHz means nearly 120 TFLOPS. Nvidia stated that on ResNet-50 training (a deep neural network), the V100 is 2.4 times faster than the Tesla P100, and for ResNet-50 inference, it's 3.7 times faster. And the P100 is already the fastest GPU around.

The increased core counts and features are possible thanks to a process shrink from 16nm to 12nm. For other Volta products, Nvidia should be able to add more cores, and each one should be more efficient than a Pascal core. With GV100 now launched, consumer focused variations can't be far off, and GV104 (aka GTX 1180/1170) may arrive sooner rather than later. So if you haven't jumped on the GTX 1080 Ti bandwagon, you might want to hold off upgrading until the fall.

Jarred Walton has been a PC and gaming enthusiast for over 30 years.

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Alex Campbell

OPEN SOURCE

Ubuntu 17.04 Sounds the Death Knell for Unity

A COUPLE MONTHS AGO, Canonical released this year's first new version of Ubuntu: 17.04. Like every release in the first half of the year, it landed in April, with a second release slated for October. After playing with the OS for a while, I think there's a few things you should know if you're looking to upgrade, or if this will be your first foray into the world of Ubuntu.

First off, there's no big cosmetic change. Ubuntu still ships with and defaults to Unity 7. While 17.04 ships with a preview of Unity 8 (as 16.10 did in October), it is not the default desktop, and it still has a few quirks. There's nothing wrong with that, but the shipment of Ubuntu 17.04 came days after Canonical announced it would be dropping the Unity project.

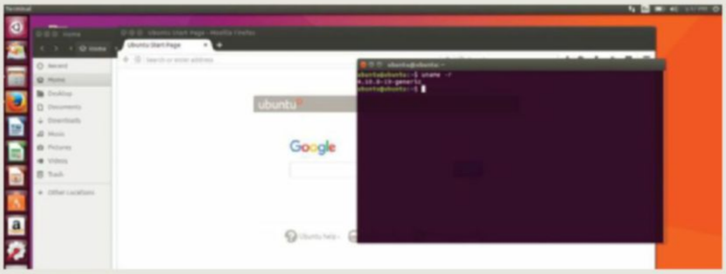
The impending doom of Unity came as a shock to those who grew to love Unity 8. It also means Canonical is dropping the goal of convergence—the idea that desktops and mobile devices should use one, seamless OS. After the death of Firefox OS, Ubuntu was the only viable open-source alternative to Android. Now it will never go mainstream.

Canonical has said that come April next year and the release of 18.04, Ubuntu will be shipping with the GNOME desktop. I know some people may not be big fans, but remember: Ubuntu shipped with GNOME before Unity was even developed.

Now's the time to start toying with other desktops. Ubuntu GNOME will become the new default, so installing that version of 17.04 will give you time to learn it. There have been lots of voices asking Ubuntu to ship with KDE's Plasma, but Kubuntu (Ubuntu with KDE/Plasma) has long been an option.

If you prefer the layout and functionality of Ubuntu from before Unity, Ubuntu MATE will offer a more "classic" experience. (MATE is a fork of the older GNOME 2.) Of course, as this is Linux we're talking about, there's nothing stopping you from installing all of these desktops on top of your existing Ubuntu installation. Most desktop managers (including Ubuntu's) allow the user to select the desktop environment to use when they log in. If you feeling like using GNOME one day, but want to switch to KDE in the afternoon, you can do that.

> If you feeling like using GNOME one day, but then want to switch to KDE in the afternoon, you can do that.



Ubuntu 17.04 still has Unity 7, but kernel 4.10 makes it worth upgrading.

The impending desktop changes are a big deal, because they'll be so visible to users. But that's not all this version of Ubuntu brings. Kernel 4.10 also ships with 17.04, which is great for people with Kaby Lake and Zen-based systems. Multithreading support was improved for Zen, while Kaby Lake saw improvements to power consumption. For power users, these are good reasons to go with 17.04 over the long-term support version 16.04, because 16.04 ships with kernel 4.4. While you can install a 4.10 kernel in 16.04, it is not officially supported by Canonical.

I, for one, welcome Canonical's decision to dump Unity. Sure, it sucks for fans of the desktop, but it shows a bit of maturity on Canonical's part. Instead of spending time on a desktop environment that only it develops, Canonical is rejoining the community. And if MATE has taught us anything about desktops, it's that fans of one system will continue development on their own so long as the source code is made available.

Alex Campbell is a Linux geek who enjoys learning about computer security.

THE LIST

MAXIMUM PC's TOP 7 MICROSOFT HARDWARE MISFIRES

7 THE OG SURFACE

Not a tablet, but a table—Microsoft's 2008 Surface was certainly an interesting idea, but its $10,000 price point excluded it from all but the most affluent homes.

6 SURFACE RT

The Surface Laptop isn't alone in pushing a closed ecosystem: this store-hobbled ARM tablet ran like a dog, and sold like one, too.

5 XBOX

The big black box launched Microsoft's console empire, but weighed as much as a refrigerator, and sold fewer than 500,000 units in game-mad Japan.

4

THE MICROSOFT MOUSE

Microsoft's first mouse, the "Green-Eyed Monster," came with a free gift for regular users: carpal tunnel syndrome. It hurts just to look at it.

3 EASYBALL

This trackball was so light, it did barely more than slide around your desk, and it only had one button. Great for tiny kids, but not much else.

2 ZUNE

Despite (or because of) heavy-handed marketing, the Zune fell flat on its face. It really wasn't bad, but Apple's iPod trounced it.

KEXP
90.3
alternative
87 88 89 90 91 92 93
Fragile Future
Hawthorne Heights

1 KIN PHONE

A cutesy, underpowered cell phone, priced to match high-end phones of the day, Microsoft canned 2010's Kin after just two months.

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HEAD TO

BY **JEREMY LAIRD**

Mac vs. PC

PC versus Mac. Mac versus PC. A debate that just won't die. That comparative proposition used to be pretty straightforward. The PC was clunky but configurable, the Mac pretty but painfully restricted. Today, the divide isn't so obvious. For starters, since Apple moved to Intel processors, it's been possible to dual-boot Macs into Windows. Equally, Windows machines such as the Surface Studio aren't just occupying similar creative territory as Macs, they're doing some things better. Time to have another look at this classic confrontation.

ROUND 1

Playing Games

Of all the possible criteria, remits, and requirements, gaming provides the most unambiguous winner. It's a nailed-down, copper-bottomed certainty that the PC is the better choice. There are far more games for the PC, and where the same game is available on both platforms, it runs better on PC. The end.

Likewise, before anyone suggests using Boot Camp as a quick-change option for transforming a Mac into a gaming PC, that only works up to a point. That's because of a Mac's limited configurability. Trying sticking an Nvidia Titan X into a trashcan Mac Pro. Yeah, right. By contrast, the PC has a wealth of options in terms of components that enable you to max out your gaming performance at any given price point.

The possible exception to this may arrive with the upcoming new Mac Pro. Apple says the new model will major on configurability, so it's just possible that we may finally have a desktop Mac with some reasonable upgrade chops. In that scenario, dual-booting a Mac into Windows via Boot Camp might make a decent part-time gaming rig. Until then, it's PC all day long, and thrice on Sundays. See ya, Mac!

Winner:
PC by a mile

ROUND 2

Being Creative

Tricky one. Apple has long styled itself as existing at the intersection between liberal arts and technology. Although that rings faintly ludicrous when you consider its puritanical policing of software in its app store, there's no doubting that generations of content creators have favored Macs.

Exactly how much better or worse Macs are for creating content is quite a subjective subject. But many people certainly do prefer the software packages and GUI of Mac in a creative context. On the other hand, whenever performance is a critical part of the package, Macs fall behind. Apple's Mac Pro workstation is staggering on with ancient hardware. In short, if you want to render in a hurry, choose a PC.

Macs also look rather old hat with the arrival of Microsoft's Surface Studio, and its intriguing form factor and input solutions. It's far more innovative as a content creation device than anything Apple has done for years—the touch bar on the latest MacBook Pros doesn't come close. For that alone, the PC deserves a marginal victory. However, when the new Mac Pro arrives next year, it could be a very different story.

Winner:
PC by a hair

ROUND 3

Going Mobile

What is the best laptop in the world? Quite often, the answer to that question has been some kind of MacBook. However, MacBooks needn't be the absolute best in every category to remain relevant.

The MacBook line is certainly more up to date technologically than Apple's tiring Mac Pro product, for instance. And when it comes to perceived quality, the best MacBooks are peerless. As a physical object, the crazy-thin 12-inch MacBook is probably the single most gorgeous portable computer yet conceived. You tend to know what you are getting with Apple portable, too. You can usually assume that great build quality and good battery life are givens. Usually! With PC laptops, it's often a bit of a gamble, especially if you are ordering online and sight unseen.

On the other hand, Apple boxes you in with a limited range of choices and configurations, a situation that is epitomized by the aforementioned 12-inch MacBook and its single USB C port for everything. PCs can be had in all shapes, sizes, specifications, and prices. In the end, it all depends on your remit and the things you care about most. An honorable draw, then.

Tie:
PC and Mac

HEAD

ROUND 4

Everyday Computing

Or to put it another way, what is the best overall combination of hardware and operating system? Macs certainly score in a number of areas. For starters, they present a more consistent face more of the time. Apple maintains closer control of both hardware and software, so you're less likely to face minor glitches, be that in terms of stability or interface quirks—when you can't easily blame someone else's hardware or the software, you just need to get everything working.

It's also true that, when equipped with a high-DPI display rendering in so-called "Retina" mode, the Mac has the PC beaten for the crispness of its fonts. They are gorgeous. Macs also integrate exceptionally smoothly with certain peripherals that have been designed for Mac (although that's a bit of a double-edged sword in the value department).

And yet MacOS is very much a walled garden compared to the huge expanse that is the Windows ecosystem. Windows remains a little rough around the edges, even Windows 10. But if you're like us, and you want maximum power and configurability, as well as the broadest software and hardware compatibility, the PC has Mac comprehensively licked.

Winner:
PC

ROUND 5

Keeping Safe

Cyber security is the bane of modern life. Even governments and major corporations regularly get hacked. For the average Joe, the safety and anonymity of numbers is probably the best protection. So, does it really matter which computing platform you choose?

In extremis, we concede the PC is probably the more vulnerable as an overall platform. That is simply a consequence of its ubiquity. It presents more live targets to the bad guys, so more of them are working on ways to compromise the PC than Macs. To put this in some kind of context, Apple lays claim to around 7 percent of new computer sales, against a backdrop of consistently selling less than the likes of Dell, HP, and Lenovo for years on end.

However, in reality, many of the threats to your online persona are platform-agnostic. If a minor website you use is hacked, and leaks a password that also happens to be the key to your online banking, it hardly matters what computer you use. In other words, in terms of the choices you can make, it's mostly down to how you manage your personal data, such as passwords, not what computer you pick.

Tie:
PC and Mac

And the Winner Is…

Scan the win-lose ratio and you might conclude that the PC has served the Mac with a brutal punishment beating. In practice, it's much more finely balanced. Partly that's because when Mac is at its best, we have no problem recognizing that it can be utterly delightful. It's also worth remembering that Apple's well implemented Boot Camp dual-booting utility means you can often have your MacOS cake and eat Windows at the same time.

Ultimately, however, so much of this comparison comes down to personal preference. For us, the power, flexibility, freedom, and configurability of the PC is what it's all about. If you're dead serious about getting things done your way, and not being held up or messed around by somebody else's idea of what makes a good computing platform, PC wins hands down.

Where Mac makes sense for us is as a secondary system with a relatively narrow remit. Powerful desktop PC at home; a thin slice of tasty Apple portability on the move. Sounds good to us. But if there could only be one, there can only be one. And it's the PC.

DOCTOR

THIS MONTH THE DOCTOR TACKLES...

> AMD CPU Temps
> PSU Problems
> Optimizing a Beast

Monitoring Heat

Hello, Doc. I own an Asus X99-Deluxe II motherboard. It includes a fan extension card with a trio of four-pin fan outputs, plus three thermistor cables that plug into the card.

Where would you suggest attaching those thermistors? And what type of adhesive would you recommend?

–Jerry Franco, Jr

THE DOCTOR RESPONDS: Choose an electrically insulated surface, such as the back of a graphics card's PCB. High-end boards have a bad habit of heating up due to voltage regulation circuitry on the other side. Readings from a thermistor may convey valuable data you're not getting from a GPU diode reporting to your favorite overclocking utility. M.2-based SSDs are another good target for thermal monitoring. They often receive insufficient airflow, and can throttle performance beyond a defined temperature.

Asus suggests using electrical tape to attach the probes, so long as the temperatures you're seeing are within spec for the adhesive.

Flight Sim Follow-Up

World War II Assets Pack includes many land, air, and sea assets for populating the *DCS World* maps.

Hiya Doc, I saw the question from Gregg Anderson about WWII-themed flight sims. I'd like to recommend *Digital Combat Simulator (DCS)*. It is by the same guys who did *IL2,* spanning everything from WWII to modern-day technology. You purchase each aircraft as an individual model that plugs into the main program, *DCS World*. Its WWII offerings include an excellent Spitfire, the Mustang, the Fw 190, and the Bf 109. Eagle Dynamics just released a closed-alpha Normandy 1944 map to backers, but it should provide a playground for these modules when it's available to everyone. There's also a module pack of AI bombers and ground vehicles for mission building, and a great online multiplayer and discussion community.

The prices are steeper than *IL2,* but the modules are gorgeous and have very realistic flight dynamics. It is also Rift/Vive-compatible, and the immersion in VR is phenomenal. **–Kelly Catton**

THE DOCTOR RESPONDS: Thank you for the recommendation, Kelly. ED's Normandy 1944 map hit alpha after the Doc's original response, so that should make a great addition to the list once it launches more broadly.

It's especially exciting to see concerted effort going into VR support. Between the available hands-on throttle and stick options and clickable cockpits, you're looking at unprecedented immersion from a hyper-realistic sim.

Reading CPU Temps

Hey Doc, I recently built a nice little gaming system using an AMD Athlon X4 860K, Biostar's Hi-Fi A70U3P mobo, 8GB of DDR3 memory, a Radeon HD 4670 1GB, and Windows Vista Home Premium SP2.

Everything is running at stock settings, but according to Speccy, my CPU hits well over 90 C playing an older *Company of Heroes* game, and it regularly sits around 70 C at idle. I've checked my cooler to ensure it's making contact. I also dug into my BIOS to ramp up the CPU fan settings. The four-pin option seems to make this problem worse, so I disabled it, and forced the fan to run at maximum speed. Is this my only solution?

Secondly, I did buy an ROG Strix RX 470 4GB and was drooling at the chance to unleash it in newer games, but it looks like I'm unable to install the drivers on an old OS—Vista reverts back to the standard VGA driver. Is there a workaround? **–Neo Lithic**

THE DOCTOR RESPONDS: It sounds like Speccy is incorrectly reading AMD's TCTL—the CPU temperature relative to its maximum operating temperature. You'll also see this referred to as thermal margin.

How can the Doc tell your readings are wrong? Well, the Athlon X4 860K shouldn't

↘ submit your questions to: doctor@maximumpc.com get much hotter than 70 C under load, much less at idle. The CPU's built-in protection features intervene as its temperature approaches that ceiling, forcing the processor to a lower power state. Performance increases once there's enough thermal margin to bring frequency back up.

Get around those erroneous readings by using AMD's OverDrive utility for reporting available margin under load. It's free, and also gives you access to overclocking controls, fan speed settings, and its own stability tests.

As for your second question, the newest cards that AMD supports under Vista come from its Radeon R9 200 and R7 200 families. You'd need to track down a used Radeon R9 290 for performance that comes close to the RX 470. But the Doc would rather see you upgrade to a newer OS. After all, AMD hasn't updated its Vista drivers since 2013, so newer games won't be optimized (if they run at all).

PSU Problems

Doc, I built a nice rig late last year and have now gone through two EVGA SuperNOVA 1,200W P2 power supplies.

This is the second PC I've built from scratch, so I substituted in the original system's EVGA 500W Bronze power supply, which seemed to chug along just fine while I waited for warranty returns.

Is something fishy here, or am I just unlucky? I did end up having to replace that first PC's power supply (a Cooler Master) after about five years.

My configuration includes an Intel Core i7-6700K at stock, a Cooler Master Hyper 212 EVO, Asus's Maximus Extreme VIII Extreme/Assembly, an Asus GeForce GTX 1070, 32GB of G.Skill DDR-3000, a 512GB Samsung 950 Pro, and a WD 3TB Red hard drive with Win 10 Home.

EVGA has been good to work with, so I don't need the Watchdog; I'd just like some advice on where to look for the gremlin causing my issues.

–Todd Bakken

CORSAIR
RM1000i

A combination of top-end processing, graphics, memory, and storage make this machine a monster.

THE DOCTOR RESPONDS: Power supplies fail for a number of reasons. Their fans go out, capacitors leak, MOSFETs overheat, and protection features can be misconfigured by the manufacturer. EVGA's 1,200W 80 PLUS Platinum-rated SuperNOVA is well regarded, though. The company is even confident enough to give it a 10-year warranty.

Although it's overkill for your hardware, that 1,200W SuperNOVA is equipped with a suite of features designed to protect it and the components behind it against problems with your mains power. Still, the Doc likes to keep his systems behind uninterruptible power supplies. Not only do they help ensure your PSU gets clean power, but they also kick in under circumstances that would normally force your PSU to shut down, potentially causing data loss. If you don't have a UPS, now's a good time to add one.

Optimizing a Beast

Hi Doc, I started reading *Maximum PC* in an effort to determine what would work best for Photoshop and some video editing. I'm not a gamer, so wanted a build that would kick ass without much or any overclocking. Though I started with something simple, I ended up going all-out.

The specs include an Asus X99 Deluxe II motherboard, an Intel Core i7-6950X CPU, 128GB of Corsair Dominator DDR4 at 2,666MT/s, a GeForce GTX 1080, a Corsair RM1000i PSU, an Obsidian 750D case, four 1TB Samsung 850 EVOs in RAID 0, a 2TB Intel DC P3500 SSD, backup via external drives, and Adobe CC.

I have Win 10 on the Intel SSD, along with my apps and images. It's 25 percent full. The SATA drives store photos and videos I want to access quickly. But I'm wondering if this setup is optimal?

Following Adobe's guide to troubleshooting Photoshop GPU and driver issues, I went to the Nvidia control panel and added Photoshop and sniffer.exe. I already told the software it could use a big chunk of RAM. Is there more I can do to optimize for Photoshop?

I also have a problem when I tell the machine to sleep and later wake it back up. The fans start spinning, lights flash, and the PC appears to be active, but the monitors don't come back on, regardless of whether I use DisplayPort, HDMI, or DVI. I have to reset the machine to turn it back on. Sometimes, not always, there's an error message.

I am considering switching back to Windows 7. Will my hardware/software handle the roll-back? **–Dominick Marino**

THE DOCTOR RESPONDS: All-out, indeed. That's a monster.

As far as your storage subsystem goes, RAID 0 is great for creating large pools of fast data. But four 1TB SSDs harnessed together multiply your chance of loss. Should one drive fail, the array breaks, taking your photos and videos out,too. This has happened to the Doc. It is not fun.

Your SSD DC P3500 reads at almost 3GB/s and writes at nearly 2GB/s. Use that huge performance to its potential. Windows, apps, and hot data can all live there without fear of slow-down. Configuring the Samsung drives in RAID 10, creating a stripe of mirrors, gives the array resiliency, keeping your photos and videos safe, while maintaining its high throughput and low latency. Sure, you give up capacity, but that Asus mobo has plenty more room for U.2, M.2, SATA 6Gb/s, and add-in card expansion.

There should be no reason to mess with Photoshop in Nvidia's drivers—that's a troubleshooting step for systems with multiple GPUs. On the Doc's machine, under "Preferences → Performance," Photoshop is set to "Use Graphics Processor." Under "Advanced Settings," Drawing Mode is set to "Advanced," and all the checkboxes (except "30-Bit Display") are selected.

The other bugs you're experiencing may be knocked out by a combination of grabbing the latest motherboard BIOS version, SSD DC P3500 firmware, graphics drivers, and Windows Update packages. If worst comes to worst, right-click on the "Windows" button, choose "Power Options," then select "Never" in the "Sleep" menu.

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AMD BUILD

BUILD IT
AMD VS.

Two very different systems ar
go head to head in this

AMD
BUILD IT!
Step-by-step guide
PG. 66

WE'VE SPENT THE LAST THREE ISSUES bigging up how important Ryzen is in the grand scheme of processor development. Without it, Intel's price gouging would likely have continued for the foreseeable future, with the red prodigy being relegated to a footnote in computing history. Ryzen, for better or worse, has changed everything, giving Intel's R&D labs the gusto to push forward with core count and chip design, and reintroducing choice into an otherwise stagnant decision-making process.

No longer is system spec purely tied to how much money you want to spend on an Intel chip, but which CPU you believe is right for you.

With most multithreading professionals looking toward Ryzen for its cheap and affordable multicore applicational use, the question is, does it warrant the fanfare it's received so far in the workstation environment? We know what the situation is with our synthetic benchmarks, and for gaming, but what about the real-world tests? What about situations that really matter? Gaming is great and all, but it's in the 3D workshops, the VR laboratories, the photo-manipulation

AMD INGREDIENTS

PART		STREET PRICE
Case	Corsair Carbide Air 740	$132
Motherboard	MSI X370 Gaming Pro Carbon	$173
CPU	AMD Ryzen 7 1800X	$465
Memory	32GB (4x 8GB) Corsair Dominator Platinum 2666	$299
GPU	AMD Radeon Pro WX 7100	$625
PSU	Corsair HX1200i Platinum	$208
Storage 1	Samsung 960 Pro 512GB PCIe NVMe SSD	$328
Storage 2	Western Digital - Black 2TB 7,200rpm HDD	$118
Cooling	Arctic Freezer 33	$43
OS	Windows 10 Home 64-bit OEM	$100
Total		**$2,491**

Prices correct at the time of going to press.

SPECIAL
INTEL

nd two very different reviewers workstation showdown

bunkers, and the video-editing powerhouses that these processors are truly designed to shine.

This all caused something of an argument in the office. So, to stop the squabble, our editor-in-chief told us to get a hold of ourselves, and to settle the debate in true *Maximum PC* fashion. A build-off, to the death…. One side Intel, one side AMD. No budget constraints, no fluff, just a pure, fair, and balanced battle between processor, chipset, and GPU type, to decide, once and for all, which platform is the better workstation standard.

So, then, the rules: Storage would be the same for each system, but we'd have free rein over the choice of processor, memory, motherboard, GPU, and cooling—and, of course, we'd have full access to any system and OS tinkering we wanted, including overclocking and memory frequency. Then, with both builds completed, it was time to benchmark the mighty beasts to settle the quarrel, and put an end to the bickering.

INTEL INGREDIENTS

PART		STREET PRICE
Case	Raijintek Asterion Plus	**$140**
Motherboard	Asus X99-E-10G WS	**$640**
CPU	Intel Core i7-6950X	**$1,600**
Memory	G.Skill Trident Z 64GB (4x 16GB) DDR4-3200	**$600**
GPU	Zotac GeForce GTX 1080 Ti 11GB Founder's Edition	**$679**
PSU	EVGA SuperNova T2 1,600W 80+ Titanium	**$385**
Storage 1	Samsung 960 Pro 512GB PCIe NVMe SSD	**$328**
Storage 2	Western Digital Black 2TB 7,200rpm HDD	**$118**
Cooling	Noctua NH-D15 CPU heatsink	**$89**
OS	Windows 10 Home 64-bit OEM	**$100**
Total		**$4,679**

GTX 1080Ti
GEFORCE GTX

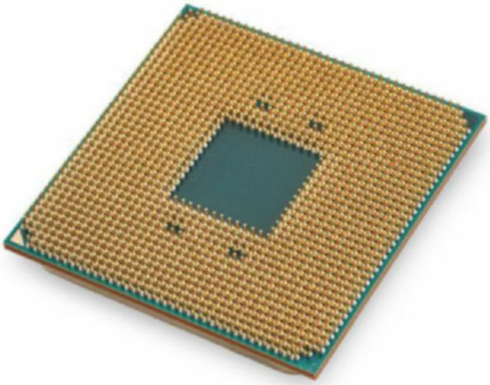
INTEL
BUILD IT!
Step-by-step guide
PG. 70

AMD BUILD

AMD MOTHERBOARD

MSI X370 GAMING PRO CARBON $173

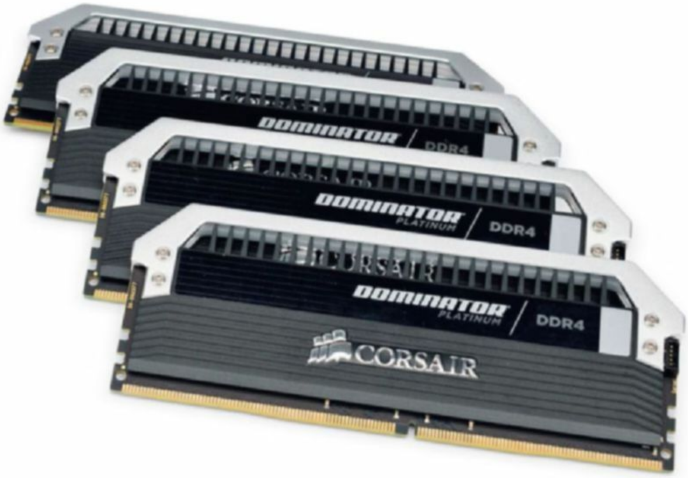
THE GAMING PRO CARBON is our current favorite offering for any AM4 build. Solid, stable performance, backed up by a rich feature set, and a reasonable price make this a tough one to beat. Dual M.2 ports and six SATA connectors make for great storage options, while a total of 16 USB ports give you plenty of connectivity, too.



AMD CPU

AMD RYZEN 7 1800X $465

THERE ARE PLENTY of good processors in the Ryzen stack, but for a workstation-class machine, you really do want to make sure you have the top dog. Eight cores, 16 threads, running at a slight overclock of 3.9GHz makes for a beefy heart for any number-crunching activity. It's only a fraction of the cost of Intel's top chip as well.



AMD GPU

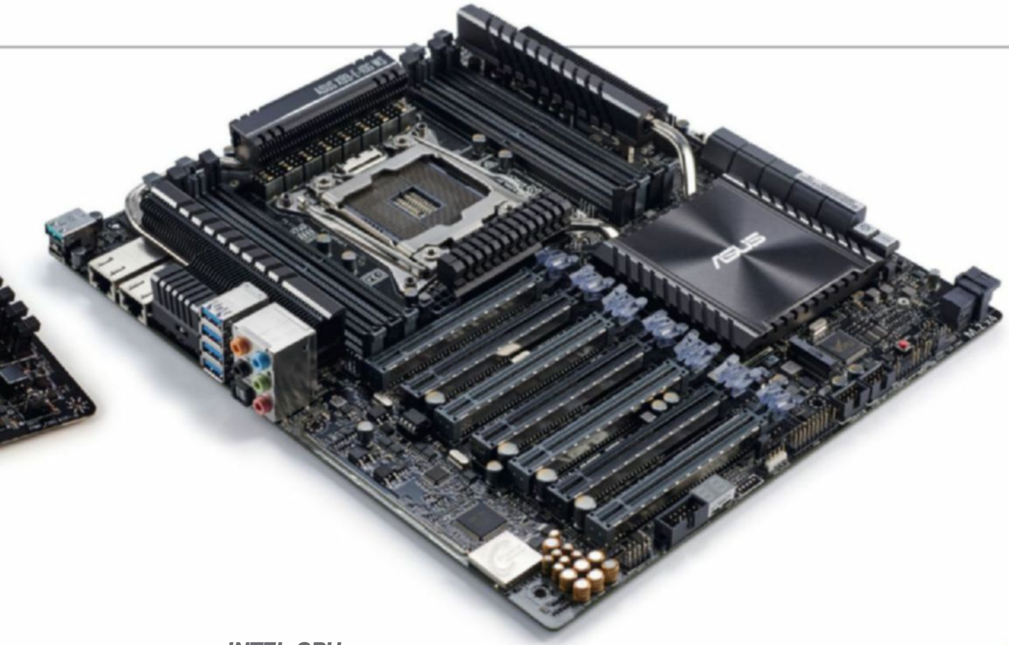
AMD RADEON PRO WX 7100 $625

PROFESSIONAL graphics cards may cost a lot more than their gaming-focused brethren, but the pay-off can be considerable in the right applications. It's all about drivers. The Radeon Pro WX 7100 is a single-slot card in delightful YInMn blue (Google it), with 2,304 stream processors, capable of hitting an impressive 5.7Tflops.

AMD MEMORY

32GB (4x 8GB) CORSAIR DOMINATOR PLATINUM 2666 $299

MEMORY CAN MAKE a considerable difference in a lot of workstation applications, so spending more on a quality kit makes sense. We've gone for a set of the Corsair Dominator Platinum 2666 sticks here, as it's a good compromise between capacity, speed, and price. If you handle a lot of large data sets, a 64GB kit may be a better idea.



INTEL MOTHERBOARD

ASUS X99-E-10G WS $640

WORKSTATION HEAVEN, thy name is X99-E-10G WS. All right, that might be a little more long-winded than we'd like, but you get the point. 10 SATA 6Gb/s ports, dual 10GbE ports, seven PCIe 3.0 slots capable of running seven workstation GPUs (in x16/x8/x8/x8/x8/x8/x8), plus it overclocks like a champ, and has incredible memory support, too.

INTEL CPU

INTEL CORE I7-6950X $1,600

IT'S A LOT OF MONEY for those 10 cores, but it's hard to deny how impressive this chip is. Capable of reaching 4.4GHz, we overclocked this monster to 4.2GHz, to keep it strong and stable, and more than capable of kicking the crap out of our rendering benchmarks.

INTEL GPU

NVIDIA GEFORCE GTX 1080 TI $679

WE COULD HAVE OPTED for a Titan Xp, or a Quadro, but decided to use something a little different from the AMD competition. The 1080 Ti packs a stunning amount of performance in a card that costs just as much as the Radeon alternative, but with enough wallop to hammer games as much as any CAD task you can throw at it.

INTEL MEMORY

64GB (4x 16GB) G.SKILL TRIDENT Z DDR4 $600

WHEN IT CAME TO MEMORY, we didn't want to absolutely demolish the competition, but we did want to lean on X99's hypothetical memory maximum. G.Skill's 64GB (4x 16GB) kit has served us well in the past. Its grand capacity and 3,200MT/s speed really dents our benchmark suite. Did it work? Best read on to find out.

AMD BUILD

AMD COOLING

ARCTIC FREEZER 33 $43

THERE IS a growing number of options for AM4 coolers, but most focus on all-in-one solutions. Here we wanted to use an air cooler that can keep the Ryzen 7 1800X in check, and the Arctic Freezer 33 steps up to the task brilliantly. Easy to install and quiet running, it's a great option.

AMD CASE

CORSAIR CARBIDE AIR 740 $132

HAVING PLENTY of space in your case is great when it comes to airflow. The Carbide Air 740 takes that to a wonderful level with its compartmented design, which has the power supply and hard drives hidden out of the way, leaving plenty of room around the motherboard. It's a joy to build in, and looks great, too, which keeps us happy.

CORSAIR
HX1200i

AMD PSU

CORSAIR HX1200I $208

TWO HUNDRED and eight dollars. That's a lot of money for a power supply, but it's arguably worth it. For a system that's going to spend a huge proportion of its life turned on, efficiency and expandability are key. Not only will the Corsair HX1200i provide you with enough options for multiple add-in cards, but it'll also waste little energy on heat, thanks to its 80 Plus Platinum certification.

AMD/INTEL STORAGE

SAMSUNG 960 PRO 512GB $328

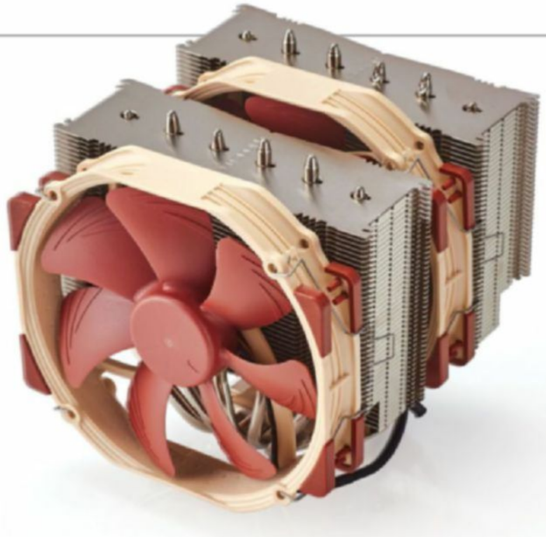
Keeping our storage fairly well balanced between these systems was key. Although memory is a big part of what makes both X99 and X370 so different, the storage situation is relatively similar between the two. The 950 Pro 512GB was the perfect choice; its exceptional file transfer speed and performance are second to none, making it perfect for our benchmark suites.

NVMe SSD
960 PRO
M.2
512GB
SAMSUNG

INTEL CASE

RAIJINTEK ASTERION PLUS $140

THE ASTERION PLUS is a full tower, acrylic-covered, aluminum box. It looks stylish, and comes with support for plenty of hard drives, and a slim 5.25-inch bay. Is it the best solution for this system? In hindsight, we perhaps should have used a Define R5 instead.



INTEL COOLING

NOCTUA NH-D15 $89

WE NEEDED SOMETHING reliable and powerful to alleviate all that heat, and the challenge fell to Noctua's NH-D15. Astoundingly, it held out fantastically well, even with the 6950X clocked at 4.2GHz. In fact, if it weren't for the fact that it's so easy to install an AIO, this may very well have been replacing our Kraken X62 that's on the dedicated test bench.

INTEL PSU

EVGA SUPERNOVA 1600 T2 $385

THIS SUPERNOVA is a 1,600W beast of a PSU, fully modular, and comes with a Titanium rating, for a power efficiency of 96 percent. Couple that with the inclusion of two eight-pins, nine eight-pin PCIe, five six-pin PCIe, and 16x SATA power, and it's one of the best equipped PSUs out there. It even supports floppy! Floppy!

INTEL/AMD STORAGE

WD BLACK 6TB $450

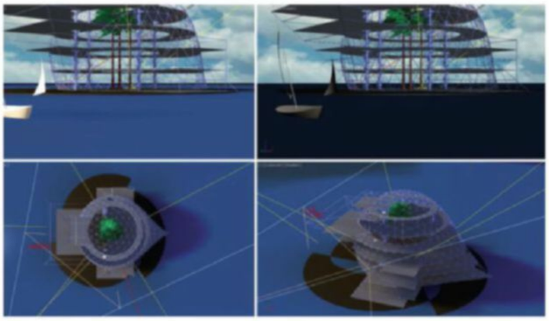
Unfortunately, Western Digital didn't get these drives to us in time for our Build It photo shoot (see pg. 66), but in an ideal world, we would have populated both systems with a WD Black 6TB HDD for onboard storage. Back these up daily on to an external NAS, and you're guaranteed to have plenty of onsite storage.

AMD
BUILD IT!
Step-by-step guide
PG. 66

CHOOSING BENCHMARKS

FORGET YOUR STANDARD TESTING SUITE, IT'S TIME TO GET SERIOUS

CAD PERFORMANCE



SPECviewperf is a harsh test of a system's CAD capabilities.

ASSESSING THE PERFORMANCE of a workstation for CAD applications isn't easy, mainly because real workloads vary so wildly. Even when handling the same models and data, what you're doing can be just as important as what you're working with. While you may be CPU-bottlenecked on some tasks, you can be held back by RAM, hard drive, or graphics card in others. There's a lot of factors when it comes to CAD work, and that's a problem when you want to know how one workstation compares to another.

Thankfully, there is a solution, and it takes the form of industry stalwart SPECviewperf. This pushes any would-be workstation through a series of grueling tests to ascertain how they'll perform in the real world of 3D CAD modeling. Because the tests used vary in complexity and rendering techniques used, there isn't an overall score or index; instead, we have results for different testing scenarios (which, in fact, are made up of multiple test runs themselves). You can download and run SPECviewperf 12.1 for free on your own machine to see how it compares: www.spec.org. Note that it's a chunky 4GB download, and not a fast one either, so grab a cold one after you press the download button.

In theory, the big takeaway from SPECviewperf is that professional graphics cards make a big difference in CAD. Unfortunately, this is muddied by the fact that plenty of the tests benefit from the raw grunt offered up by the GTX 1080 Ti, so it isn't the whitewash for the AMD Radeon Pro WX 7100 that you might expect. The GTX 1080 Ti does incredibly well in the DirectX Maya benchmark, for instance, while the WX 7100 is almost 10 times faster in the penultimate SNX test. If you're serious about CAD, then upgrading to a Quadro P6000 might make sense, although you need to be prepared to drop up to $5,000 on such a card.

Note that these tests are largely processor-agnostic, running on a single core for the most part, so the focus is very much on the graphics card in your system. Even so, as with gaming scenarios, a faster core clock on your CPU can make a difference here.

ON TO THE NITTY-GRITTY. You can build all the fancy workstations you want, but if you don't have some way of measuring real-world performance across them (which is, let's face it, the entire point of this feature), it amounts to very little outside of hypothetical potential throughput. Synthetic benchmarks are good at giving you a rough idea of how a system responds, but they're also fallible. Just take a step into Asus's Crosshair VI BIOS, and you'll quickly spot the option to enable performance boosts for both Cinebench and GeekBench, if you should so desire.

Which brings us to the question of what benchmarks we should use. For both of the Build Its, found on pages 66 and 70, we stuck with our traditional suite, which we use across most of the systems we build for those pages—more game-heavy, with a peek at processor performance and storage output. However, for this feature, we really wanted to focus on a more accurate depiction of how each platform operates in a working environment. Which meant delving into real-world programs.

From the get-go, we knew we wanted to include something that utilized CAD clients. Because most software associated with CAD reaches the tens of thousands of dollars mark, we opted for SPECviewperf, a free-to-download benchmark, which runs a number of CAD applications to truly test your GPU's design capability. Next on the list was video editing—for this, we took a copy of the latest version of Adobe's Premiere Pro CC, and coupled it with a project file we borrowed from our parent company's corporate advertising division. For photo manipulation, we went with Gigapan Stitch. Designed to test memory capacity, bandwidth, and CPU prowess, this takes hundreds, if not thousands, of images, and stitches them all together to create a massive panorama, with PSB files reaching upward of 96GB in some places, depending on DPI settings. Finally, we ran a few more synthetics for our own understanding of how the systems performed across memory, and our traditional rendering benchmarks, including SiSoft Sandra and X265, which are available for free or on trial.

INTEL
BUILD IT!
Step-by-step guide
PG. 70

SPECVIEWPERF 12.1 BENCHMARKS

VIEWSET	RYZEN WORKSTATION	ZERO POINT	INTEL WORKSTATION
3ds Max *(Index)*	95.72 (-39%)	157.54	124.3 (-21%)
Catia *(Index)*	103.42 (20%)	85.93	105.69 (23%)
Creo *(Index)*	81.41 (31%)	62.32	62.6 (0%)
Energy *(Index)*	4.06 (-53%)	8.57	11.73 (37%)
Maya *(Index)*	75.2 (-45%)	136.04	175.43 (29%)
Medical *(Index)*	34.32 (-31%)	49.72	52.64 (6%)
Showcase *(Index)*	65.43 (-36%)	101.71	141.35 (39%)
SNX *(Index)*	96.79 (1,011%)	8.71	10.52 (21%)
SW *(Index)*	111.97 (84%)	60.98	67.80 (11%)
	0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%		0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point has a Core i7-7700K running at a stock frequency of 4.5GHz, an Nvidia GeForce GTX 1080 8GB, 16GB of Corsair Vengeance LPX DDR4-2400, and a 250GB Samsung 850 Evo, mounted on an Asus Maximus IX Hero mobo.

AMD BUILD

VIDEO RENDERING

TURN OFF
THE FLASH

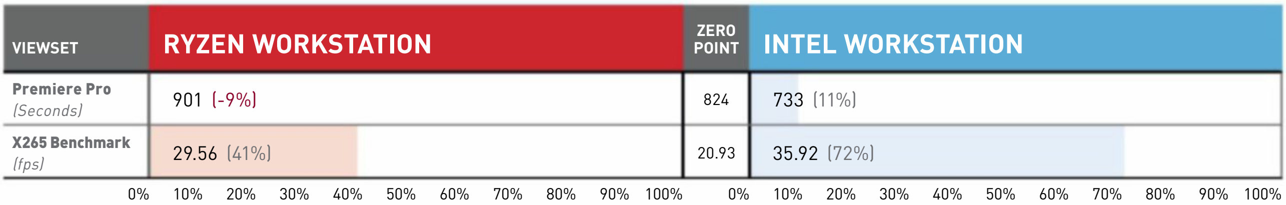
Premiere Pro in all of its processor-eating glory.

THE VIDEO EDITING community is divided on which editing software is best. Apple's Final Cut Pro and Adobe's Premiere Pro are the two most commonly used applications, followed by the now-defunct Sony Vegas (recently bought out by Magix). Although Premiere offers a far greater set of tools than its barely supported Apple counterpart, Final Cut Pro's render times are far superior, especially when it comes to exporting 4K video. That said, Final Cut Pro isn't available on Windows, therefore anyone lacking the investment into Apple's Mac OS ecosystem has little choice when it comes to video editing software.

We used Adobe Premiere Pro CC for our real-world benchmarks, taking 180GB-worth of files, a preconstructed Adobe project file, rendering out in 4K in H.264 at maximum bit depth and render quality, and timing how long it took each machine to complete the task.

As far as performance goes, Premiere is always a mixed bag, because it relies heavily on both the CPU and the GPU, leveraging workloads to whichever core makes the most sense. Its Media Rendering engine supports both OpenCL and CUDA, with the latter taking center stage when it comes to eking out that extra performance. The number of cores and clock speed also matter, because although not every processor is fully utilized during rendering, the more you have and the faster those individual cores run, the better.

On top of that, we also ran our X265 benchmark. This is an interesting one because it doesn't rely on any particular GPU, but purely transcodes video from one file format into another, so it acts as a fairly heavy synthetic CPU test, producing average fps figures for four consecutive runs, which are then averaged out again to provide the final score for comparison.


VIDEO RENDERING

Our desktop zero-point has a Core i7-7700K running at a stock frequency of 4.5GHz, an Nvidia GeForce GTX 1080 8GB, 16GB of Corsair Vengeance LPX DDR4-2400, and a 250GB Samsung 850 Evo, mounted on an Asus Maximus IX Hero mobo.

AMD CONCLUSION
THE VALUE PROPOSITION

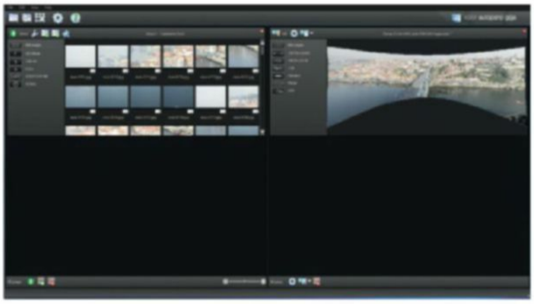
BOTH OF THE MACHINES we built for this feature are incredible. But there can be only one winner, and in terms of raw performance, there's no getting away from the fact that Intel's Core i7-6950X is an absolute beast. It is expensive, though, and getting the best from that chip will set you back a serious amount of cash. Our Ryzen machine, meanwhile, is much more thrifty, which means that while we do lose out in the drag race of straight performance, Ryzen has the Intel system easily beat in terms of value for money—20 percent performance improvements in most of the tests doesn't balance well with the 80 percent price difference.

In light of that, you could emphasize the win on this front by focusing even more on the value of the individual components. We wouldn't step away from the core of the RAM, motherboard, and CPU (although an argument could certainly be made for stepping down to the Ryzen 7 1700), but everything else is potentially up for grabs. You could certainly pick a more affordable power supply, and while we're personally huge fans of the case, it's an obvious place to save a bit of cash—especially as it won't affect the bottom-line performance at all.

The one component that would be easy to replace is the graphics card, as you could hit pretty much the same performance in many tasks by swapping to a Radeon RX 580 (saving $375). Of course, if you use applications that benefit from a pro-level card, that doesn't make sense, but for everyone else, it's an easy win. The fact that you'll hit even higher frame rates in games won't hurt either.

Overall, though, we're happy with how the Ryzen build came together, and how it has performed in testing. It's a strong system that proves that AMD is back on a par with Intel. We still have a few reservations in some areas—RAM support is still not quite where we would like it to be, and as the platform is new, we ran into problems during testing that we couldn't be certain weren't down to the particular test. Even so, if you're looking to build a power workstation machine, AMD is definitely an option once again. It's been a while since we've been able to say that.

IMAGE STITCHING



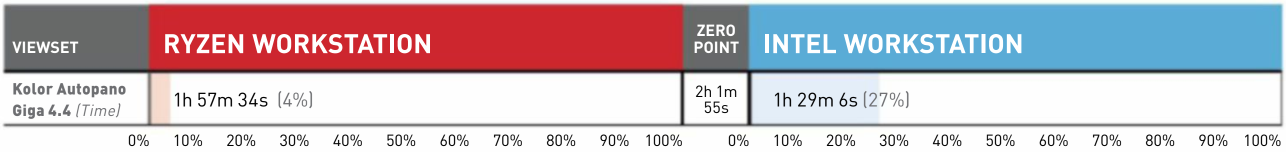
The world's most frustrating 2-12 hour benchmark.

IT SHOULDN'T COME as much of a surprise when we say that assessing how these machines handle image editing varies depending on what you're doing. When you're packing loads of memory, fast storage, the fastest processors money can buy, and great graphics cards, many tasks that take a while on a standard desktop are too easy for our monster rigs. We searched for workloads that actually made sense, but kept coming up with operations that finished within seconds, or were too specific to be of much use. In other words, if you're looking for a workstation for image editing, both machines fulfill the role competently.

Not all image-based tasks are created equal, though, and if you're looking for serious system draining, image stitching is a good option. The concept is to take a series of photographs that cover a wide panorama, and stitch them together to create a massive final image. In order to get consistent coverage for these images, a "robot" is often used, and that's exactly what was done to get the live data set for our testing. The shots in question were bracketed for improved contrast, and the final image count came in at a cool 690 images, with each measuring 5184x3456 pixels.

There's some necessary overlap between images, but the final panorama is 136,758x50,502 pixels, and weighs in at 22GB (we saved it out as a Photoshop file for more manipulation if needed). These things are a serious resource hog to work with and move around, but the final results are incredible. See for yourself by going to www.gigapan.com/cms/view. The software we used for this test, Autopano Giga 4.4, uses as many CPU cores as you can throw at it, loads of RAM, and requires fast storage, too. No real surprises on the result front—the added core count of the Intel build, along with the larger capacity memory, makes a real difference.

GIGAPAN IMAGE STITCHING



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INTEL CONCLUSION

PRICEY BUILD, PRICEY PRIZE

WE RECENTLY received a comment on the old book of faces, asking about the point of processors with more than four cores. It got us thinking: How do you best explain the proposition behind a workstation, like the two builds we have here? This is what we came up with.

Going from a four-core, eight-thread processor to an eight-core, 16-thread one can cut render times in half. If you shave 15 minutes off a 30-minute render, and do that twice a day, five times a week, that's 2.5 working hours saved in a week. Multiply that out by a year, and it's around 125 man hours saved. Take the average wage of an experienced video editor ($30 an hour), and that's a total of $3,750 saved, purely in time, in a single year.

What we're getting at is that, for the self-employed, or the corporate busybody looking to improve their company's efficiency, investing in good systems, much like infrastructure, will always pay for itself in the long run. And that's something you partially see with the two systems we have here. Ryzen's value proposition in contrast to our Intel build is huge. We knew from the start that Intel could never win a fight based on trying to spec a similarly priced machine, so performance was the goal—smashing the opposition through sheer brute force, graphically, computationally, and in I/O support and memory was key.

We've gotta give credit to Ryzen—it's exceptionally well equipped at an outstanding price in comparison to Intel, but it wasn't without its limits. Initial setup and getting memory to operate above 2,133 was still challenging, even with the latest BIOS updates, and Gigapan, in particular, proved troublesome (although that's also true of the Intel rig). Ultimately, recommending one rig over the other is difficult. If you've got the cash to spare, the Intel one is easier to set up, more powerful, and far more stable than its Ryzen counterpart. But, in all honesty, with AMD's 16-core Threadripper HEDT platform and Intel's Skylake-X right around the corner, it would be better to see what both of those new platforms muster up first, before committing to either ecosystem.

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Sager One Year Limited Warranty Policy: 30-Day Money-Back Guarantee. If the equipment does not work as promised, or if you are not fully satisfied, we will issue a full refund upon the return of all original equipment. 1-Year Parts and Labor Limited Warranty. Lifetime Toll-Free Technical Support. Sager One Year Limited Warranty, Two Year Limited Warranty and Three Year Limited Warranty Policy Applies to End Users in the United States of America only. Extended Warranty Available: Check out this comprehensive package of service/support. Sager Corporate Offices 18005 Cortney Court, City of Industry, California 91748 Tel: 626.964.8682, Fax: 626.964.2381 Hours: Monday-Friday 7:30a.m. - 6p.m.(PST) American Express, VISA, MasterCard & Discover Credit Cards Accepted - No Surcharge. Cashiers Checks Welcomed. ©2017 by Midern Computer, Inc. All rights reserved. Ultrabook, Celeron, Celeron Inside, Core Inside, Intel, Intel Logo, Intel Atom, Intel Atom Inside, Intel Core, Intel Inside, Intel Inside Logo, Intel vPro, Itanium, Itanium Inside, Pentium, Pentium Inside, vPro Inside, Xeon, Xeon Phi, and Xeon Inside are trademarks of Intel Corporation in the U.S. and/or other countries. All company and/or product names mentioned herein are trademarks and/or registered trademarks of their respective companies. Prices and specifications are subject to change without notice. Opened software and shipping charges are non-refundable. 30-Day money back guarantee does not include freight or shipping and handling charge. *Free UPS Ground Shipping valid to contiguous US order only.

NP9172 Notebook
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- NVIDIA® GeForce™ GTX 1070 8GB GPU
- Opt. NVIDIA® GeForce™ GTX 1060 or 1080 GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 500GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Killer DoubleShot™ Pro with Smart Teaming (1000Mbps LAN + Killer Wireless-AC 1535)
- Thunderbolt Gen3 & USB 3.1 Type-C Ports
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Headphone output w/ESS SABRE HIFI Audio DAC

NP9152 Notebook
$1,899

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- Windows 10 Home
- 7th Generation Intel® Core™ i7-7700 Processor
- 15.6" Full HD IPS Matte Display (1920x1080) w/NVIDIA® G-SYNC Technology
- Opt. 15.6" FHD,120Hz 5ms Matte Display with G-SYNC
- NVIDIA® GeForce™ GTX 1060 6GB GPU
- Optional NVIDIA® GeForce™ GTX 1070 GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Killer DoubleShot™ Pro with Smart Teaming (1000Mbps LAN + Killer Wireless-AC 1535)
- Thunderbolt Gen3 & USB 3.1 Type-C Port
- Headphone output w/ESS SABRE HIFI Audio DAC

NP8177 Notebook
$1,799

FREE UPS GROUND SHIPPING*

- Windows 10 Home
- 7th Generation Intel® Core™ i7-7700HQ Processor
- Opt. unlocked Intel® Core™ i7-7820HK Processor
- 17.3" Full HD IPS Matte Display (1920x1080) w/NVIDIA® G-SYNC Technology
- NVIDIA® GeForce™ GTX 1070 8GB GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC 8265 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Headphone output w/ESS SABRE HIFI Audio DAC
- Slim design with only 1.18 inch thin

NP8157 Notebook
$1,699

After $50 Instant Savings

- Windows 10 Home
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- 15.6" Full HD IPS Matte Display (1920x1080) w/NVIDIA® G-SYNC Technology
- Opt. 15.6" 4K QFHD or FHD 120Hz 5ms, Matte Display with G-SYNC
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- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
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- Built-in 2.0M FHD Camera & Fingerprint Reader
- Headphone output w/ESS SABRE HIFI Audio DAC

NP8176 Notebook
$1,549

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- Windows 10 Home
- 7th Generation Intel® Core™ i7-7700HQ Processor
- 17.3" Full HD IPS Matte Display (1920x1080) w/NVIDIA® G-SYNC Technology
- NVIDIA® GeForce™ GTX 1060 6GB GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC 8265 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 1.18 inch thin

NP8156 Notebook
$1,499

FREE UPS GROUND SHIPPING*

- Windows 10 Home
- 7th Generation Intel® Core™ i7-7700HQ Processor
- 15.6" Full HD IPS Matte Display (1920x1080) w/NVIDIA® G-SYNC Technology
- NVIDIA® GeForce™ GTX 1060 6GB GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC 8265 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Sound Blaster® X-Fi™ MB5 Sound System
- Slim design with only 0.98 inch thin

NP7850 Notebook
$1,299

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- Windows 10 Home
- 7th Generation Intel® Core™ i7-7700HQ Processor
- 15.6" Full HD IPS Matte Display (1920x1080)
- NVIDIA® GeForce™ GTX 1060 6GB GPU
- 16GB Dual Channel DDR4-2400MHz Memory
- 250GB WD Blue M.2 SSD + 1TB 7200RPM Hard Drive
- Full Color Programmable backlight Keyboard
- Intel® Dual Band Wireless-AC 8265 + Bluetooth
- Built-in 2.0M FHD Camera & Fingerprint Reader
- Sound Blaster® Cinema 3 Sound System

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$799

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- NVIDIA® GeForce™ GTX 1050 2GB GPU
- 8GB DDR4-2400MHz Memory
- 1TB 5400RPM Hard Drive
- Single Color White-LED backlight Keyboard
- Intel® Dual Band Wireless-AC 3165 + Bluetooth
- Built-in 2.0M FHD Camera
- Sound Blaster® Cinema 3 Sound System
- Slim design with only 0.98 inch thin

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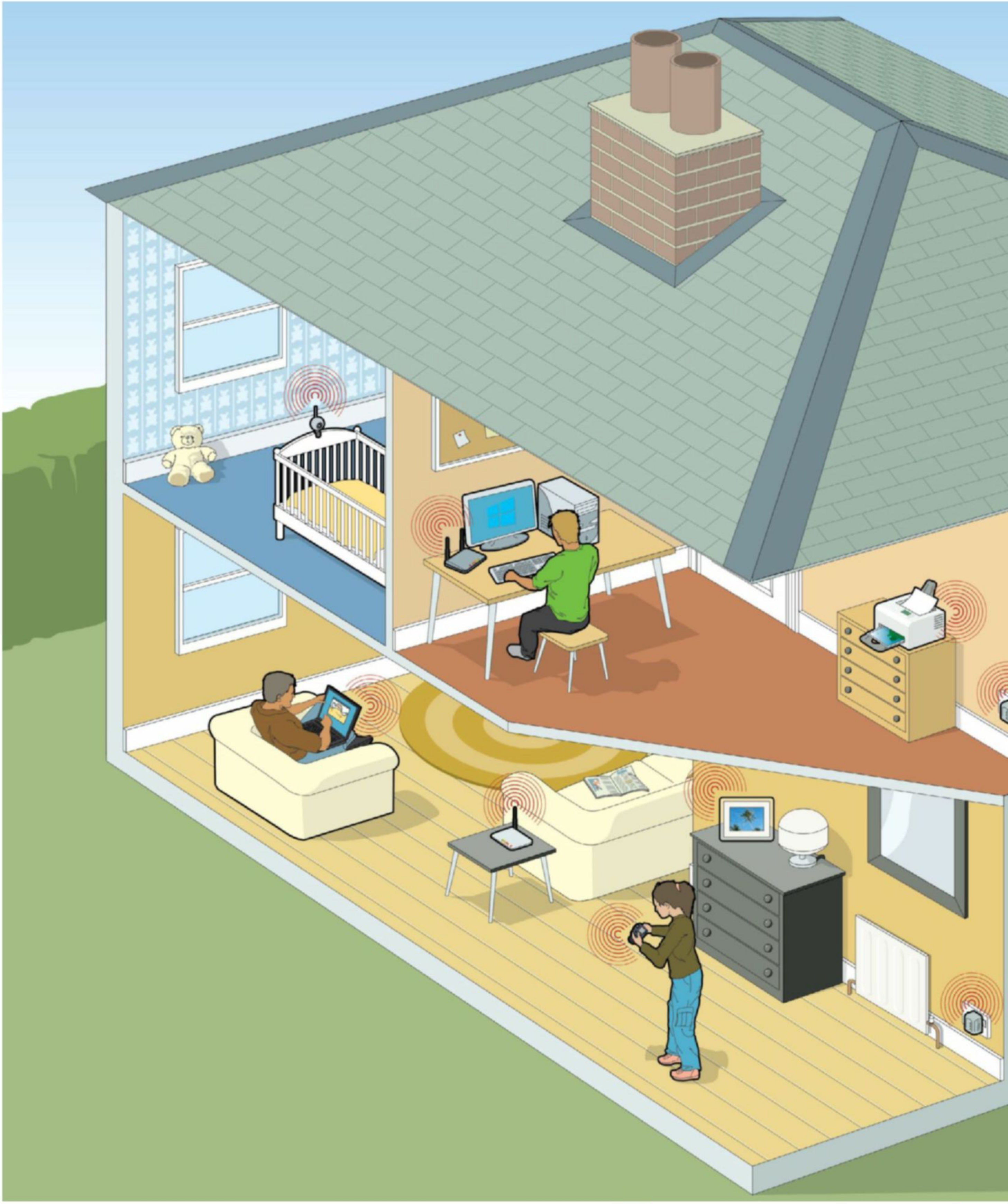

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SET UP THE PERFECT NETWORK

Upgrade, optimize, and secure your network with the help of *Nick Peers*

UNLESS YOU'VE BEEN MISSING in action since the Y2K Bug failed to destroy civilization, you already have some form of networking in your home. A typical home network combines wired and wireless networking, with your main PC, possibly a printer, and perhaps a games console plugged into a router using an Ethernet cable, and other devices—those in other rooms as well as mobile devices—connecting wirelessly.

At the center of your network lies your modem and router (or modem router if you have an all-in-one unit). This acts as a bridge between the network in your home—a Local Area Network, or LAN—and the world's best-known Wide Area Network (WAN), the Internet.

It's possible you only use your network for accessing the Internet, but if you're smart, you'll have found ways to use its sharing abilities to even greater effect: Why buy a printer for every computer in your home, for example, when one networked printer can be shared by all? But ask yourself this: Are you using your network to its maximum? Is it performing as fast and efficiently as it should? Could you expand your network to even greater benefit? Are there problems—Wi-Fi congestion and interference, for example—that need resolving?

In this feature, we answer these questions and more. We show you how to benchmark your network, plus reveal its topography. Then we help you determine if your router needs upgrading, and examine ways to expand your network to every corner of your home.

Once you've physically set things up, we look at how to optimize your network: improve security, boost range and performance, ease Wi-Fi congestion, and expand its capabilities by offloading services on to a NAS. There's time for some file-sharing tips, before we show you how to access your network securely when away from home. It all adds up to one supercharged network, so light the fuse, and prepare for blast off....

LET'S START BY TAKING STOCK. Make a note of your existing router's make and model, then check out its specifications, which you'll need when determining whether an upgrade is worthwhile. Then take an inventory of all the devices that are currently connected to it. Don't forget any smart home tech you've added, such as a security camera or SmartThings hub.

Struggling to remember what's connected where? Use the free Fing app on your mobile, or download Advanced IP Scanner (www.advanced-ip-scanner.com) on your PC to scan your network for connected devices. Both tools provide you with as much information as possible to help you identify the devices in question. In the case of Advanced IP Scanner, you're given the device name, IP, manufacturer, and MAC address—click the ">" next to an entry to reveal the resources it shares.

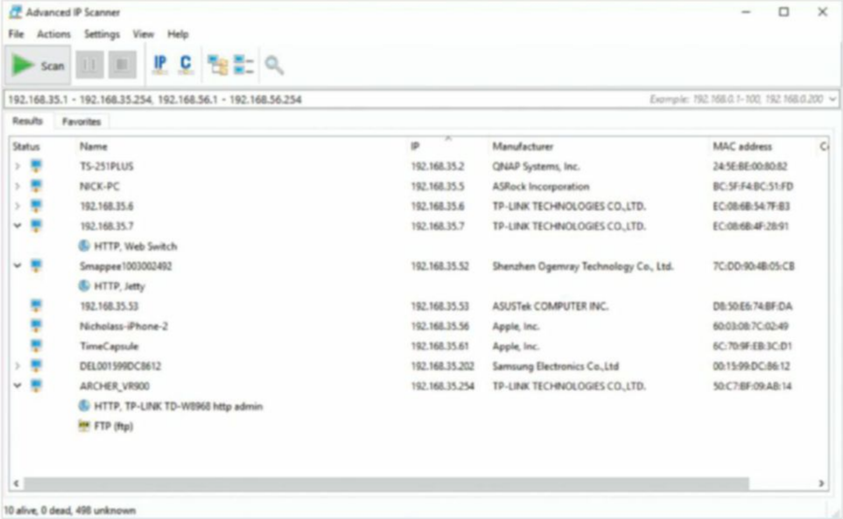
The inventory could reveal unwanted devices on your network—in which case, our tips on securing your network (pg. 44) will help you lock these out—but for most, it merely reminds you what's connected.

One last thing before we begin: Consult the box on benchmarking (opposite) to see how to perform some quick tests on your network as it currently stands. You can then rerun these as you make upgrades and optimizations to your network, to see whether they have an effect.

Pick a New Router

Given the router's critical role in your network, this should form the starting point for your network tweaking. First question to answer: Is it up to the task? If you don't want your network to be hobbled by slow transfer speeds, make sure it supports the latest wired (Gigabit Ethernet) and wireless (802.11ac) technologies.

You're not limited to the modem router supplied to you by your Internet provider—and if you're currently paying a monthly rental fee for it, it's likely you'll get better long-term value by purchasing your own model. If the modem and router are separate, you might even want to consider buying an integrated modem router to save on space and free up a socket, but make sure the model you pick works with your current Internet connection—it's usually a choice between cable, ADSL (regular broadband), and VDSL or ADSL2+ (super-fast or fiber-optic broadband). If you're not sure about the acronyms, check with your Internet provider (or ask on its support forums) for confirmation.



192.168.35.1 - 192.168.35.254, 192.168.56.1 - 192.168.56.254

Example: 192.168.0.1-100, 192.168.0.200

Status	Name	IP	Manufacturer	MAC address
>	TS-251PLUS	192.168.35.2	QNAP Systems, Inc.	24:5E:BE:00:80:82
>	NICK-PC	192.168.35.5	ASRock Incorporation	BC:5F:F4:BC:51:FD
>	192.168.35.6	192.168.35.6	TP-LINK TECHNOLOGIES CO.,LTD.	EC:08:6B:54:7F:B3
⌄	192.168.35.7	192.168.35.7	TP-LINK TECHNOLOGIES CO.,LTD.	EC:08:6B:4F:28:91
	HTTP, Web Switch			
⌄	Smappee1003002492	192.168.35.52	Shenzhen Ogemray Technology Co., Ltd.	7C:DD:90:4B:05:CB
	HTTP, Jetty			
	192.168.35.53	192.168.35.53	ASUSTek COMPUTER INC.	D8:50:E6:74:BF:DA
	Nicholass-iPhone-2	192.168.35.56	Apple, Inc.	60:03:08:7C:02:49
	TimeCapsule	192.168.35.61	Apple, Inc.	6C:70:9F:EB:3C:D1
>	DEL001599DC8612	192.168.35.202	Samsung Electronics Co.,Ltd	00:15:99:DC:86:12
⌄	ARCHER_VR900	192.168.35.254	TP-LINK TECHNOLOGIES CO.,LTD.	50:C7:BF:09:AB:14
	HTTP, TP-LINK TD-W8968 http admin			
	FTP (ftp)			

10 alive, 0 dead, 498 unknown

Advanced IP Scanner takes an inventory of all the devices connected to your network.

Use a Wi-Fi expander to extend the reach.

Essential Features

So, what should you look for in your new model? Start with the wired ports—make sure your new model offers Gigabit Ethernet to maximize transfer speeds. Most routers should offer four Ethernet ports—if you have more than four wired devices to connect, or your devices are in a different room to your router, this may not be a deal-breaker. See the "Expand your network" section later for more help in this area.

Next, choose a model that supports 802.11ac (AC) wireless networking. These days, most routers create two separate wireless networks on different channels: 2.4GHz and 5GHz. The 2.4GHz band is supported by all devices, but is where congestion and interference from neighboring networks can sap its performance (more on mitigating this later). The 5GHz band is traditionally less congested, subject to less interference, and much quicker over shorter ranges.

The 5GHz channel's major drawback is its limited range—particularly on older Wireless N routers that supported both channels. Wireless AC routers improve the 5GHz range, thanks to detachable antennae, which can identify where connected devices are, and target the signal directly at them, using a process called "beamforming."

You'll also see AC routers are rated using different numbers, from AC1600 up to AC2800. The latter number indicates the maximum combined Wi-Fi speed for the router's two channels—typically 300-600Mb/s for the 2.4GHz range, and then 1Gb/s up for the 5GHz range.

If you do a lot of streaming, you might also be tempted by a model offering Multi-User MIMO (MU-MIMO). MU-MIMO improves the efficiency of multi-device streaming by streaming multiple packets simultaneously, but beware: Behind the hefty premium is the fact that your wireless devices must explicitly support MU-MIMO, and right now, not many do.

Handy Extras

Routers are becoming increasingly smart, so look out for these features: UPnP, which automatically opens the ports required to stream to and from the Internet (albeit at a cost to security). Then there's QoS, or Quality of Service, which enables you to apply bandwidth limits to specific devices.

Some routers even offer VPN services, enabling you to set up encrypted network connections to a work network—if you're looking to set up your own VPN server, try Netgear's Nighthawk range, or see the "Offload network services" section later. Bonus points go to routers that offer USB

Netgear's Nighthawk routers offer advanced features.

Make sure your router offers enough Gigabit Ethernet ports.

TP-Link's Archer range is fast and affordable.

ports for printers or external hard drives, transforming them into network devices.

All these features come with additional costs attached, so set yourself a budget and decide what—if any—additional features you need. Which router should you buy? We're fans of TP-Link's Archer AC range (www.tp-link.com), which work with an existing modem, but if the idea of a modem router appeals, visit www.techradar.com/reviews/pc-mac/networking-and-wi-fi/modem-routers to find inspiration.

Expand Your Network

Your central hub is now sorted, what next? First, if you're connecting any devices directly to the router's Gigabit Ethernet ports, check they're using CAT5e cable. Inexplicably slow connections may be fixed by simply swapping out the cable—if your router (or switch) provides LEDs for each connected port, verify they're green (for Gigabit), as opposed to amber (for 10/100Mb/s connections).

It's likely your devices aren't all conveniently clustered around your router. You could look to run CAT5e cabling through your walls to each room using a structured home wiring setup (see www.structuredhomewiring.com), but for most people, that's not practical.

If you're happy to go wireless, you might find the upgrade to a wireless AC router is sufficient to extend its range to your entire home, but if there are still "dead" zones, where the signal is weak or non-existent, you have one of two options. The first, cheaper option is to try repositioning your router in a more central location, but if that isn't possible, invest in a Wi-Fi repeater, which acts as a relay. Place it in a halfway location between your router and the dead zone, and it should be able to boost the signal into that zone, although you shouldn't expect stellar performance.

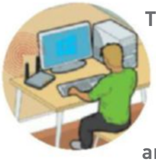
You also need to create separate SSIDs for this new Wi-Fi network—how about appending something on to the end of your existing network's SSID, such as "TP-LINK_5GHz-office"?—and then pair your devices to the new network, as well as the old one. They then automatically switch between the two as required, and because they're all linked to your router, your network access remains consistent across all these Wi-Fi hotspots. Prices start from as little as $20 for Wireless N models that only extend the range of 2.4GHz networks. Wireless AC models start from around $35 for an AC750 model.

A new trend is the emergence of "Wi-Fi Mesh" systems, which combine router, modem, and Wi-Fi extenders in one piece of kit. These are then sold in multi-packs to dot around your home, but they come with a hefty price tag: $300 for a three-pack Google Wi-Fi system, for example.

Extend Via Your Circuits

Wireless isn't always a practical solution for extending your network throughout your home. Perhaps your router isn't in your

BENCHMARK YOUR NETWORK



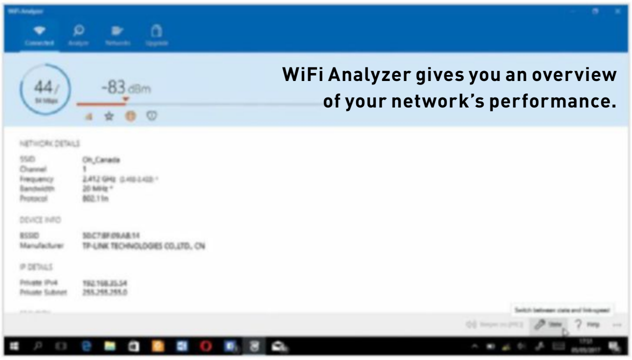
There are several tools and techniques you can employ to benchmark your network performance and range. Find out how fast your Internet connection is compared to what your Internet provider claims by visiting **www.lifewire.com/benchmark-2626177**.

If you're benchmarking with a view to streaming video, consider 5Mb/s a reasonable requirement for a single HD stream from the likes of Netflix. The demands scale up for Ultra 4K—25Mb/s—but for most people, you don't need a superfast connection for one or two streams. One figure worth noting is the upload speed—this is always much lower than the download speed, but could be critical if you plan to stream video over the Internet from your network.

How can you test the strength of your Wi-Fi signal in different parts of your home? Install the free WiFi Analyzer app from the Microsoft Store on your tablet or laptop, then move around your home and record the signal strength (in dBm) and equivalent speed (Mb/s). See how far the range goes before it disappears, and try to test the 5GHz channel as well as the 2.4GHz channel.

If you'd like to test your network's file transfer capabilities, download and run LAN Speed Test Lite from **www.totusoft.com/lanspeed1** on your main PC, and use it to connect to a shared folder on another device on your network. Test different file sizes (say from 2MB up to 2GB), and perform at least three tests with each, before recording the average.

Compare the results of all your tests against the type of connection you're transferring files over—1,000Mb/s for Gigabit Ethernet, 300Mb/s-plus for wireless. These are theoretical maximums—don't worry if you're getting half these figures, but pay attention to specific results, where it seems one device or connection is struggling in comparison to elsewhere on your network.



WiFi Analyzer gives you an overview of your network's performance.

44 / 54 Mbps
-83 dBm

NETWORK DETAILS
SSID Oh_Canada
Channel 1
Frequency 2.412 GHz
Bandwidth 20 MHz
Protocol 802.11n

DEVICE INFO
Manufacturer TP-LINK TECHNOLOGIES CO.,LTD., CN

IP DETAILS
Private Subnet 255.255.255.0

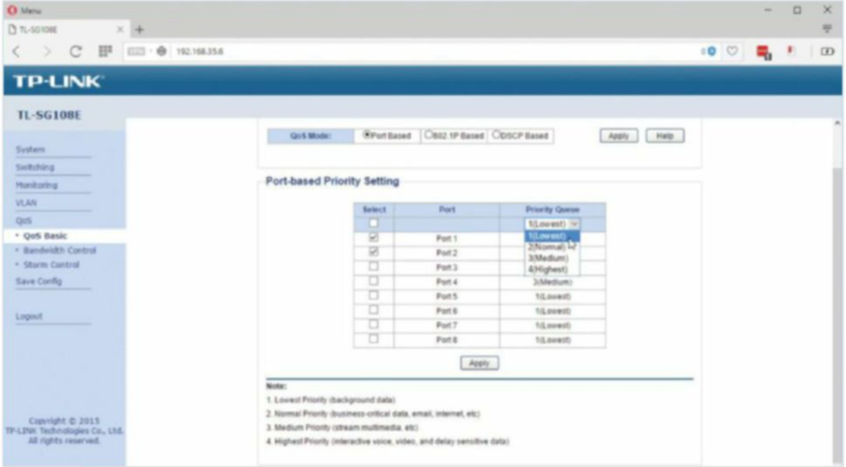
office, where most of your equipment is kept, and you'd like to keep those on a wired network. If structured home wiring doesn't float your boat, consider extending your network through your electrical circuits using HomePlug equipment instead.

You need a minimum of two HomePlug (also known as powerline) adapters: one to place next to your router, and the other to put in the room to which you want to extend your wired network. Each adapter plugs into a spare power socket, so if you're short on sockets, make sure you choose one with a pass-through option. Connect the first adapter to your router using the supplied Cat5e cable, then connect the Cat5e cable in your office to your wired device or—if you plan to connect multiple devices—a network switch (see below). Add more adapters for each room that needs them.

When switched on, press a button on the main adapter, and it automatically detects the others, and simply extends your wired network from your router into each room in your house. Adapters of varying speeds are available but, before you begin, remember that the overall speed of your powerline network is determined by the slowest powerline adapter on it, so if you've already got older equipment, it might be time to upgrade the lot.

Look for HomePlug AV2 models that promise a minimum 1Gb/s (1,000Mb/s) or faster, remembering that—as with all networking (and particularly the wireless sort)—the advertised speeds are theoretical maximums. Powerline equipment is notorious for being affected by "noise" on the electrical circuit, so expect to achieve no more than half the advertised figure, and possibly less. That said, if you're transferring data between two devices on the same switch, the data doesn't need to go through the HomePlug adapter, so should transfer much quicker.

Some HomePlug models offer two or more Ethernet ports to avoid adding a switch. Expect to pay around $100 for a decent starter kit, such as TP-Link's TL-PA9020P KIT, which comprises a pair of two-port Powerline adapters, offering up to 2Gb/s transfer speeds, and pass-through sockets. For more information on powerline networks, visit www.homeplug.org.



QoS Mode: ● Port Based ○ 802.1P Based ○ DSCP Based

Port-based Priority Setting

Select	Port	Priority Queue
☐		1(Lowest)
☑	Port 1	
☑	Port 2	
☐	Port 3	
☐	Port 4	3(Medium)
☐	Port 5	1(Lowest)
☐	Port 6	1(Lowest)
☐	Port 7	1(Lowest)
☐	Port 8	1(Lowest)

Note:
1. Lowest Priority (background data)
2. Normal Priority (business-critical data, email, internet, etc)
3. Medium Priority (stream multimedia, etc)
4. Highest Priority (interactive voice, video, and delay sensitive data)

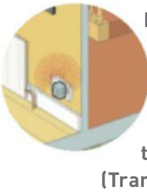
You can administer managed switches through your browser.

Add a Switch

A network switch helps manage the transmission of data between wired devices on your network. If you run out of Ethernet ports, or you've extended your network to another room in your home, you need an additional switch to connect multiple devices to your router.

There are two types of switch: unmanaged and managed. Unmanaged switches are shipped in a fixed configuration and perform a similar role to older (now depreciated) network hubs, in that they

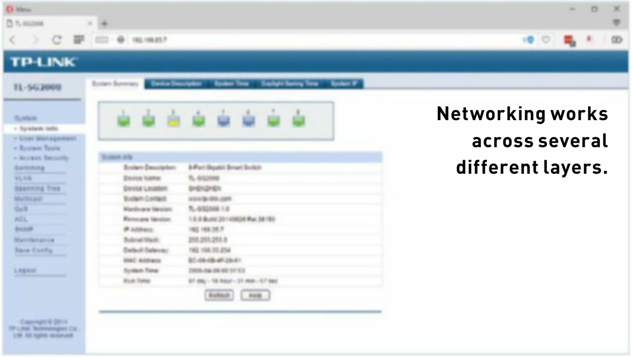
THE TOPOGRAPHY OF NETWORKING



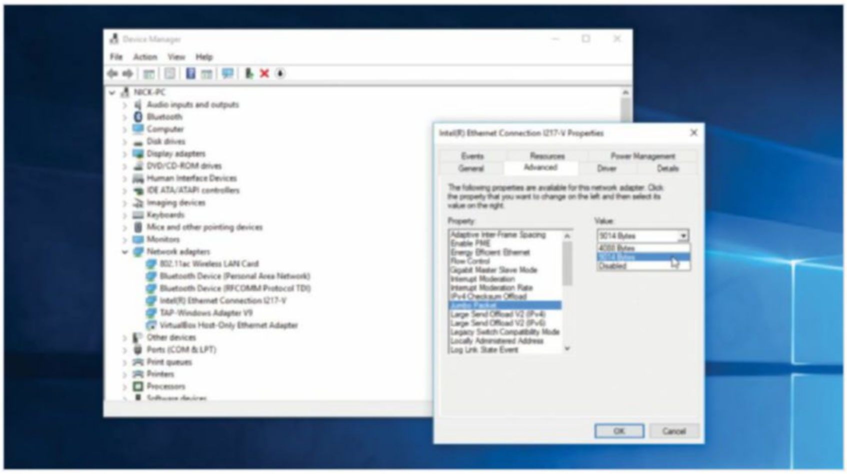
How do computers talk to each other over networks and the Internet? The answer is through the TCP/IP model. TCP (Transmission Control Protocol) is the method used by computers to connect over networks, while IP (Internet Protocol) is the way in which data is transferred using "packets" of information. This model can be broken down into four basic layers: Application, Transport, Internet, and Network Access.

At the top is the Application layer, which splits into three basic elements. At the very top sit the programs you use to access the Internet, such as your email client. Beneath this is the "presentation" element, where data is translated into a suitable format for sending over the network—if it needs compressing or encrypting, that happens here. Then there's the "session" element, which determines the type of connection—or session—that's established between you and the remote computer. Examples include HTTP/HTTPS for connecting to websites and servers, FTP for basic file transfers, and SMTP for email.

Beneath this is the Transport (TCP) layer. This manages how the data is delivered, by converting it into "packets" for sending, then making sure they're safely delivered, and reassembled at the other end in the correct order. It also works in reverse for packets received by your computer. The third layer is the Internet (or Network) layer. This is the layer that covers how the data is addressed and then routed between devices. It's also where the actual delivery of data occurs, using IP packet-switching. The final, bottom layer is the Network Access (or Network Interface) layer. This is where error detection and correction take place as the data is packaged and transported, plus it's where you'll find the physical hardware—typically Ethernet or Wi-Fi—that connects you to your network and the Internet.



Networking works across several different layers.



Experimenting with jumbo frames can potentially increase throughput.

simply relay the connection from your router's switch to any connected devices.

If you want more control over a specific part of your network, a managed switch will appeal. Managed switches enable you to control the network at a local level by providing certain features that give you greater control over how devices connected to the switch behave. You can, for example, apply QoS settings to manage bandwidth demands, or create Virtual LANs (VLANs) that enable you to isolate certain devices from the rest of the network, without having to physically disconnect them.

Of more practical interest is a feature called jumbo frames (also known as Maximum Transmission Units, or MTUs to their friends). Data is transferred across networks in packets known as frames, and the 802.3 standard originally defined the maximum frame size as a meager 1,518 bytes. If the devices on your network can handle it—and that includes the router and any switches—you can increase this figure to increase the size of your frames, and improve network performance through more efficient transfer of data: fewer frames mean reduced resource usage and faster performance.

Entry-level managed switches cost as little as $25 for TP-Link's TL-SG108. It comes pre-configured to work as a dumb switch, but you can tweak its settings through its Easy Smart Configuration Utility tool. Visit http://uk.tp-link.com/faq-697.html for a handy guide to configuring and testing jumbo frame settings. If you want more features—such as Link Aggregation support for potentially boosting your NAS drive's performance (see Spring 2017 issue)—check out TP-Link's SG-T2008 ($55, www.newegg.com) instead.

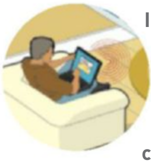
Optimize Current Networks

Now is a good time to benchmark your network again, following the advice in the box (pg. 41)—you should immediately see improvements in Wi-Fi speed if you've made the jump from Wireless N to Wireless AC, and hopefully better range, too, particularly on the 5GHz channel.

The next phase of optimization involves first moving any devices that can detect the 5GHz Wi-Fi network over to it—not only is this channel quicker, but it'll reduce congestion and help balance your wireless devices' demands better. If you're having issues with the range of the 5GHz network, move your wireless device closer to your router to make the initial connection—once

Extend your network without burying cable in walls.

ADVANCED FILE-SHARING TIPS



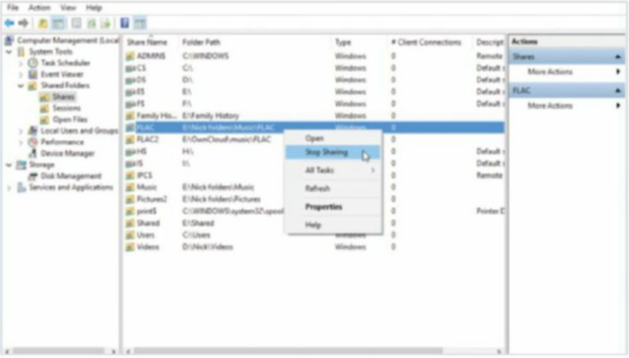
If you've not yet done so, set up file sharing by clicking the network icon in the Taskbar Notification area and choosing "Network & Internet settings," then clicking "Sharing options." Expand "Private" to verify file and printer sharing is switched on, along with network discovery. Ignore HomeGroup connections, then expand "All Networks" to disable public folder sharing, ensure 128-bit encryption is enabled, and switch on password-protected sharing for security reasons.

It's no longer compulsory, but a good idea to verify all your computers are on the same workgroup—WORKGROUP by default, but if you change it to something else, repeat for all the PCs in your network. Type "workgroup" into the "Search" box and click "Change workgroup name" to do so.

Forgotten which folders you've shared? Windows no longer displays a folder icon to indicate shared folders, but you can get a comprehensive look (including the paths to the folders themselves) by right-clicking the "Start" button and choosing "Computer Management → Shares." Double-click "Shared Folders" for a list—right-click a share to stop sharing, or choose "Properties" to limit the number of users that can access the share at any time.

Want to create a secret share that's not visible? Simply add $ to the end of its name, and it won't show up anywhere in people's network browsers—the only way to access the share is to type its path exactly into the address bar of File Explorer: \\COMPNAME\SecretShare$.

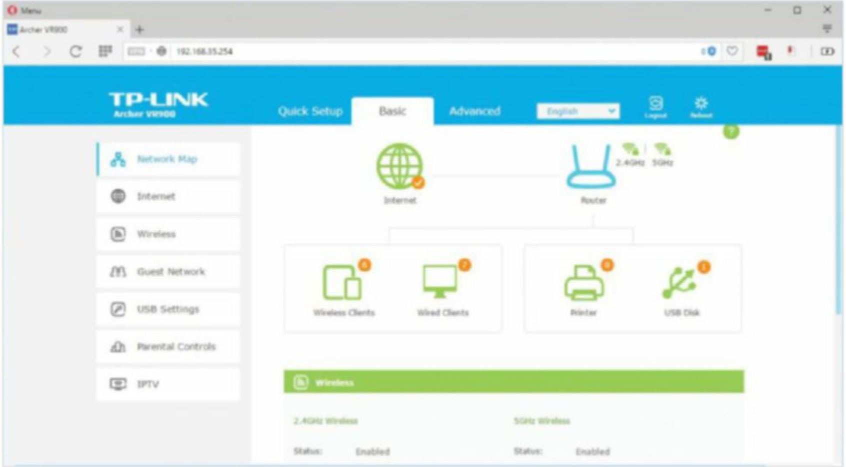
Finally, if you're signed into Windows using a Microsoft Account, when you come to access a share on that PC from a Mac or Linux computer, don't type your full email address into the username field; instead, type the name before the @, and it should connect with no problems.



Manage all your shares from one window.

it's paired, your router's beamforming technology should help extend its range to your device. If there are still issues in certain areas, consider a Wi-Fi repeater.

Next, let's look at your 2.4GHz network. Using WiFi Analyzer (see benchmarking box, pg. 41), switch to the "Analyze" tab, where you'll see a series of overlapping circles on a graph, indicating what channels are being used by your—and neighboring —networks. A recommended channel is listed—access your router's configuration settings through your browser, and look in the 2.4GHz Wi-Fi section for a channel setting. Change this from automatic to the recommended channel (often 1 or 11). Click "Save." After a pause, return to WiFi Analyzer to see what effect it's had. Be prepared to experiment with different channels, and test in different parts of your home, particularly weak signal areas, to improve performance in areas critical to you.



2.4GHz Wireless
Status: Enabled
5GHz Wireless
Status: Enabled

Transfer as many devices to the 5GHz channel as you can.

More Configuration Tips

Let's return to the router configuration utility and trawl through its settings, looking for more tweaks to perform. Start by tightening up security—if you've never done so, change the password required to access your router. Also, change the Wi-Fi network passwords from those supplied with the router, and ensure WPA-PSK2 with AES encryption is selected.

Protect yourself against drive-by hackings by disabling SSID broadcast, enabling MAC filtering, and switching off the DHCP server, then check the firewall, and switch off UPnP port forwarding. Finally, look for a remote access option to administer your router from outside your home network—switch it off. See the October 2016 issue's hack-proof feature for more details on how to apply these changes.

Away from security, look for an "Address Reservation" option within your router configuration's LAN settings—this enables you to apply static IP addresses to specific devices, without having to configure the device itself. One reason to do this would be if you have a device that moves from network to network—now you can reserve it a specific address on your own network, without having to change network settings when you move to another.

Lock Down Problem Users

Want to manage your kids' online access? Frustrated at your housemate's tendency to hog the bandwidth when you want to stream video to your room? To rein in your kids, hunt down the parental control settings in your router configuration utility. You should be able to select devices by IP or MAC address, then apply restrictions, such as when they have Internet access, and block sites according to rating, keyword, or other criteria. To ensure nobody monopolizes the bandwidth, look for a "QoS" or "Bandwidth

TIGHTEN REMOTE ACCESS SECURITY

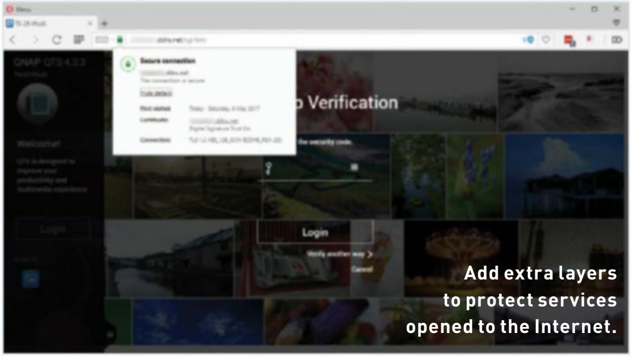
Applications and services such as Plex are simple and relatively safe to set up for remote access, although it pays to keep an eye on any reported vulnerabilities, then disable the service until they've been patched. One of the reasons they're safer is that you can only access them with your user credentials using an app or specific web address (such as Plex Media Player and **https://plex.tv/web**). They can't then leverage that connection to do anything else.

Other services, such as logging on to your NAS or even your router, are trickier, because anyone with a web browser, knowledge of your IP address or DDNS address can attempt to log on—or brute-force their way—to your device.

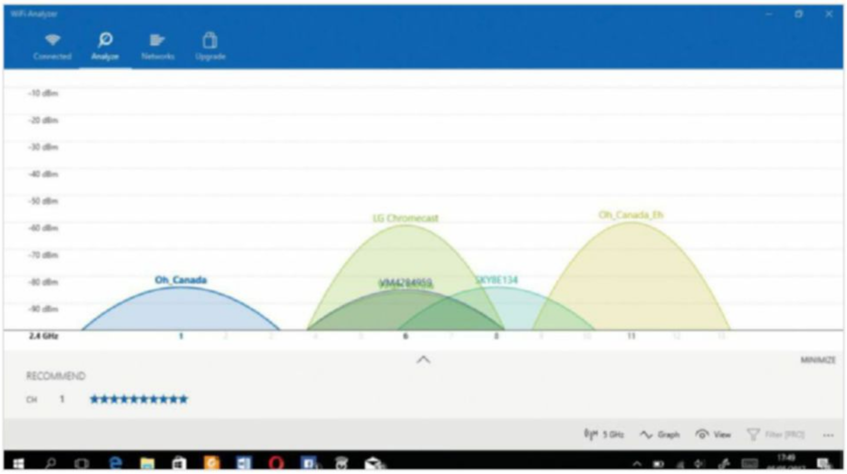
If you are opening up a device for outside access, you'll almost certainly want to use a dynamic DNS address—effectively a user-friendly web address that points to your computer's public IP address—to make logging on easier. Start by signing up for an address using a provider such as No-IP.com (**www.no-ip.com**) or similar. Link this to your device via its configuration utility, but then take additional steps to add multiple layers of security to the connection.

First, look to force an encrypted (HTTPS) connection to the device in your device settings, then aim to back this up with an SSL certificate for your DDNS address (for example, QNAP allows you to purchase its own low-cost SSL certificate, or quickly add a free certificate from Let's Encrypt). Switch on two-step verification if it's offered, and enable Network Access Protection to block IP addresses for set periods of time (or permanently) after a set number of unsuccessful login attempts.

One last thing: ask yourself if you really need to access this device outside of your network—if you don't need to log on when away from home, disable all remote access.



Add extra layers to protect services opened to the Internet.



We recommend moving your 2.4GHz network to a less congested channel.

Control" section. You can set restrictions by IP address or range, or specific ports, which enables you to apply limits to specific applications. You can set a priority level, which only applies restrictions when other connections are in play, or set upstream and downstream limits that ensure plenty of bandwidth is left over.

Offload Network Services

If you're relying on your PC to provide network services, such as a media server or backup drive, now is a good time to look at transferring those to a suitable device, freeing up resources on your PC (plus enabling you to power off your PC without worrying about losing access). You could press an older PC into service, or you could invest in a mid-range Network Attached Storage (NAS) device. For maximum flexibility, choose between Synology and QNAP models—the QNAP TS-231 is a good entry-level choice, or if you're looking for something that can handle multiple HD media streams, splash out on a QNAP TS-251+ (around $300 without disks). The 251+ has a quad-core Celeron, and comes with 2GB RAM onboard (you can upgrade this to 8GB)—more than enough to run multiple servers side by side.

A powerful NAS lets you set up everything from secure—and private—cloud backup to a full-blown media server. We've got Plex Media Server handling our media needs, coupled with OwnCloud for backup and sync (configured for network access only), as well as Syncthing for synching media to and from the device. A USB hard drive plugged in the back expands the onboard storage, and is available for all our network devices.

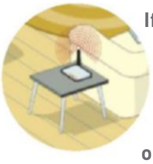
Critically, what the NAS has done is allow us to reclaim much-needed system resources from other computers—it also means we no longer have to leave them switched on 24-7 for network services to be available around the clock.

Access Outside the Network

Why limit your shared resources to just your home? It's possible to open parts of your network to the wider Internet, either for personal use or to allow others to access your content from anywhere. How you do this depends on what you want to share—for example, to access your Plex media collection from elsewhere requires you to go to "Settings → Remote Access" in Plex to enable the feature. If UPnP routing is enabled, your router should do the rest; otherwise, you need to manually forward the port listed in Plex (32400 by default) to your server's IP address, using your router's configuration utility.

Making other network services accessible over the Internet is more dangerous—see the box on tightening your security (opposite) for tips on mitigating these risks. ⏻

POWER UP YOUR ROUTER



If you're happy with your router's hardware specification, but disappointed with its configuration utility or the tools it offers, you may be able to get a free "upgrade" without having to shell out for a whole new router. Alternatively, you could breathe life into an old router by converting it into a wireless repeater or VPN server, thanks to the broad range of additional features provided by a community-built open-source firmware called dd-wrt.

Start by visiting www.dd-wrt.com and clicking the "Router Database" link. Type the first few letters of your manufacturer or model to see if it's in the database and whether or not it's supported (make a note of any revision numbers, and verify your router is the same revision, usually by checking the label underneath it). While most manufacturers are represented, not all of their models are supported.

If your model is supported, head to www.dd-wrt.com/wiki to obtain the firmware, then follow the instructions to download and install it—these vary from model to model, so make sure you're following the correct advice. Typically, you're using your existing firmware's upgrade page to "upgrade" to the dd-wrt firmware, but sometimes you may need to log on to your router via the command line.

Please note that there is a very real possibility that you'll "brick" your router, which means it will be rendered unusable. The installation section of the wiki goes into this in great detail, and if you're put off by the process, that's not necessarily a bad thing—this is something that requires a great level of technical skill, and we're not in a position to offer any support should you decide to go down this route, unfortunately. With this in mind, we suggest trying this with an older router—perhaps even one that you've picked up on eBay for a few dollars.

Why not turn an old router into a repeater or VPN server?

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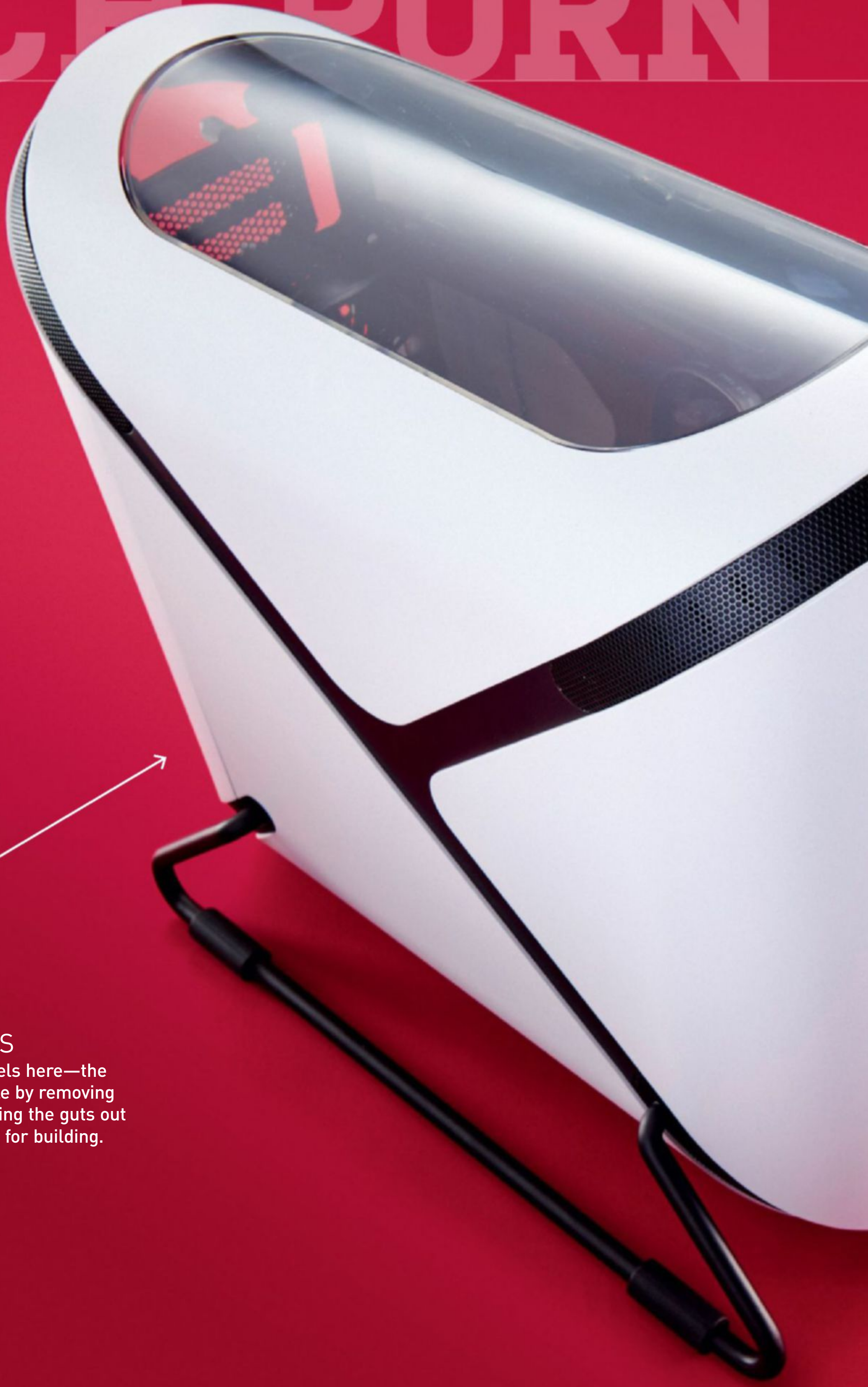
TECH PORN



1 CURVED WINDOW

What about that curved window, eh? It's perfect for anyone wanting to place their system on the floor, yet still keen to keep their GPU in clear sight and in full flight. We love it for this alone.

2 NO SIDE PANELS

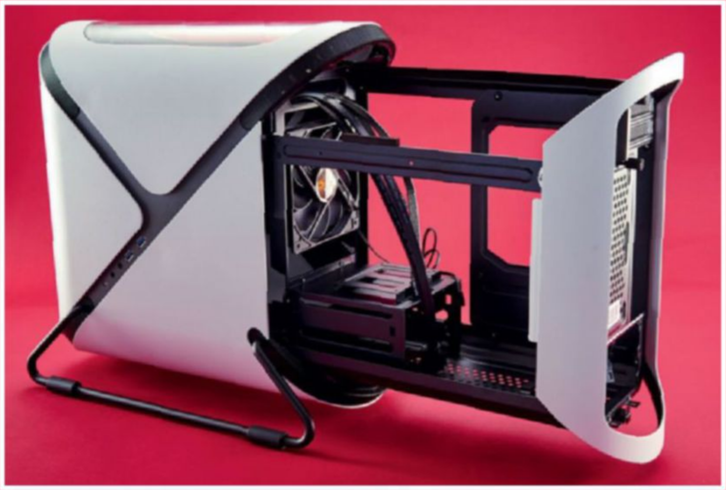
There are no side panels here—the internal chassis is accessible by removing two thumbscrews, then sliding the guts out of the back, then off the rail for building.

BitFenix Portal

YOU'RE ABOUT TO WITNESS us waxing lyrical about a chassis for Tech Porn. That's right: a PC case. Do you know how many cases we've looked at in Tech Porn over the last two years? One. Even Phantek's prestigious Evolv ATX lineup didn't warrant an appearance in our hall of fame. So why this one? Why has BitFenix's Portal made it on to these pages, where so many others have failed? Simply put, because it's different. Staggeringly so. BitFenix was the pioneer of turning the ITX chassis into more than just another low form factor HTPC: In 2012, it launched the Prodigy, ruffling the feathers of the purists by releasing a quirky, graceful, willowy box, far bigger than anyone had seen before, and packing an astonishing 230mm fan in the front.

The Portal takes that innovative Prodigy pedigree and crams it into a new style of chassis unlike anything we've ever seen. A convex roof adorns the top, ready to show off the heart of any gaming system, while the small form factor and outlandish design make it look more like something from *Alien* than anything built on Earth.

Combine all that with its intrinsically complex sliding rail internal mechanism, to allow for easy construction and tinkering on the fly, and what you're left with is a chassis that takes innovation and case design to new heights, without necessarily breaking the bank. **–ZAK STOREY**



3 OVERALL DESIGN

The Portal's tight lines, contrasting colors, and curved panels give this case an air of elegance. Black, white, window or without, the choice is yours—and, boy, does it look good!

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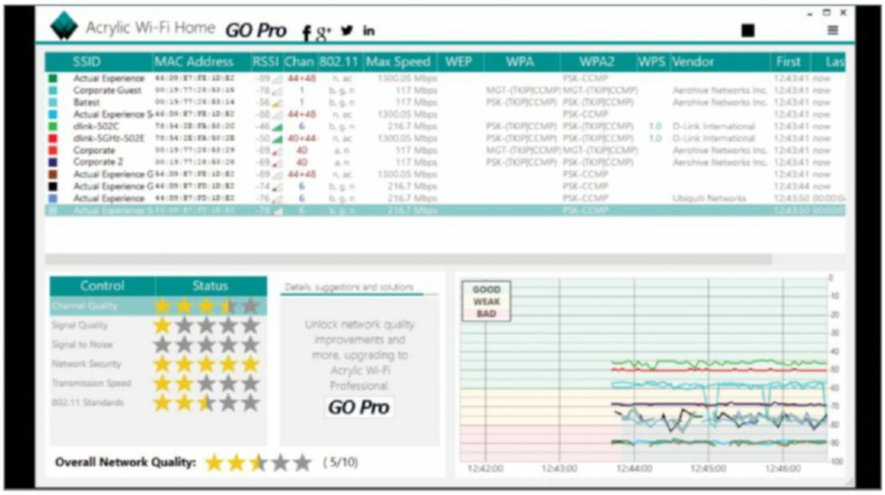
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802.11 Standards
Details, suggestions and solutions
Unlock network quality improvements and more, upgrading to Acrylic Wi-Fi Professional
GO Pro
Overall Network Quality: (5/10)
GOOD
WEAK
BAD
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12:45:00
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ACRYLIC WIFI

Curious to find out how bad the wireless congestion is in your area? Debating whether moving your network over to a different channel might help? Then try downloading the Acrylic WiFi network analyzer. Not only does it give you all the pertinent details about local networks, including bandwidth speeds, but it also presents you with a quick five-star breakdown in an easily digestible format. www.acrylicwifi.com

MAKE – USE – CREATE

54
Follow our advanced Kodi tips and tricks

58
Play around with digital 3D modeling clay

66
Our AMD and Intel workstations fight mano-a-mano

ZAK STOREY
REVIEWS EDITOR

A MOD TOO FAR?

Another month, another batch of goodies arrives in the office. This time, it's something very special indeed. A full set of custom sleeved cables from CableMod, built exactly to my spec.

Traditionally, high-end, liquid-cooled, aesthetically pleasing systems come with custom sleeved cables, painstakingly produced by modders and enthusiasts, with intricate detailing, stealth cable combs, or cable lacing to ensure every single aspect of their build pops.

It's something I have a huge amount of respect for, yet lack the patience or time to fully commit to. That's where CableMod steps in. We've used cable kits from these guys in the past, for a variety of power supplies and different builds, yet we've never dived into the custom side of the site before.

CableMod's "configurator" section enables you to enter how many cables you want, what length you'd like, what material you want them sleeved in (nylon or paracord), and what color you want each individual cable, within each bigger cable, to be. This does whack the price up (our total kit cost $320), but the quality is outstanding.

Couple them with a set of clip-in cable combs to train the cables, and they look perfect. Unfortunately, I can't show you what they look like right now, but rest assured, they'll be coming to an issue near you soon. www.cablemod.com

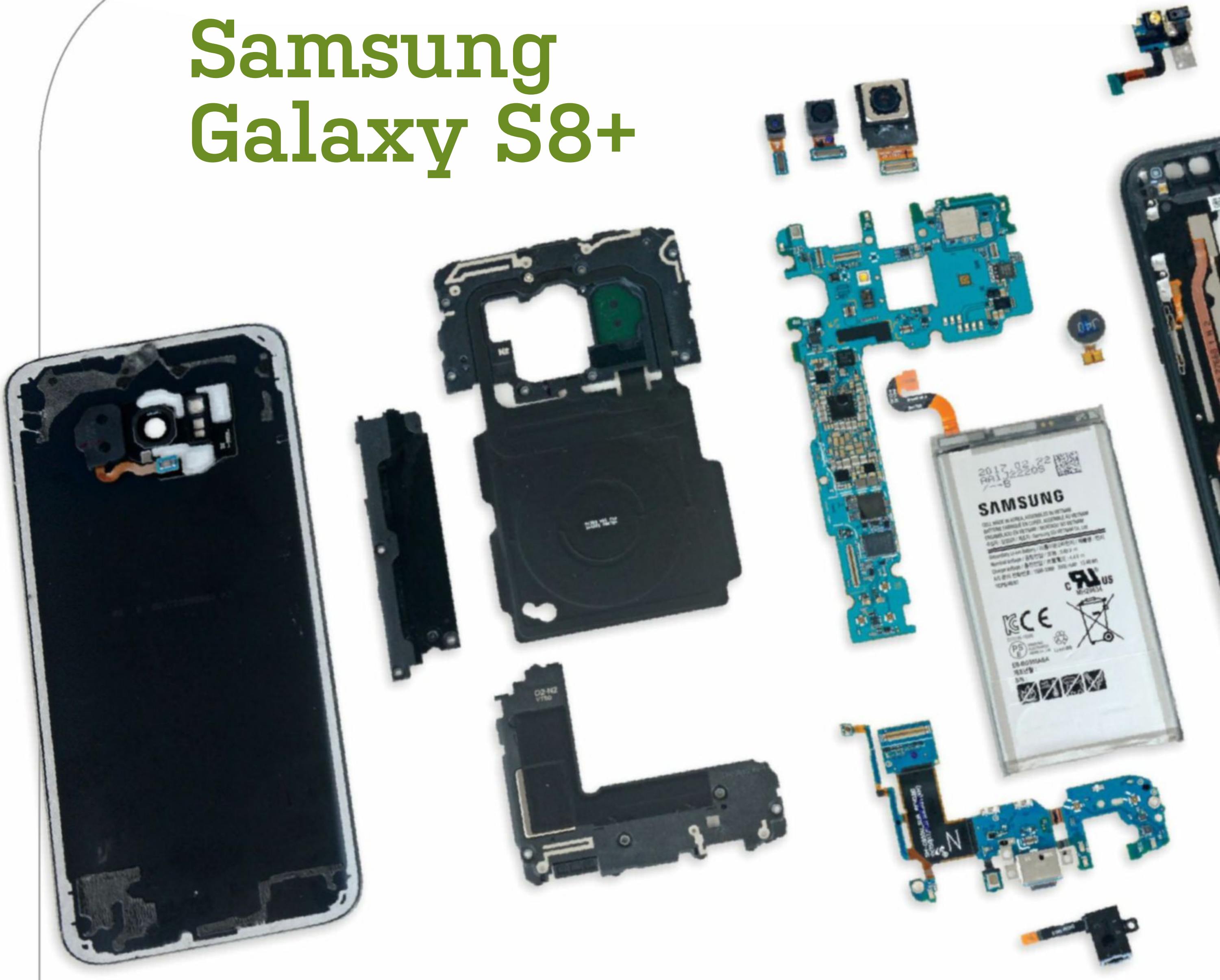
↘ submit your How To project idea to: comments@maximumpc.com

IFIXIT presents:

AUTOPSY

THIS MONTH WE DISSECT...

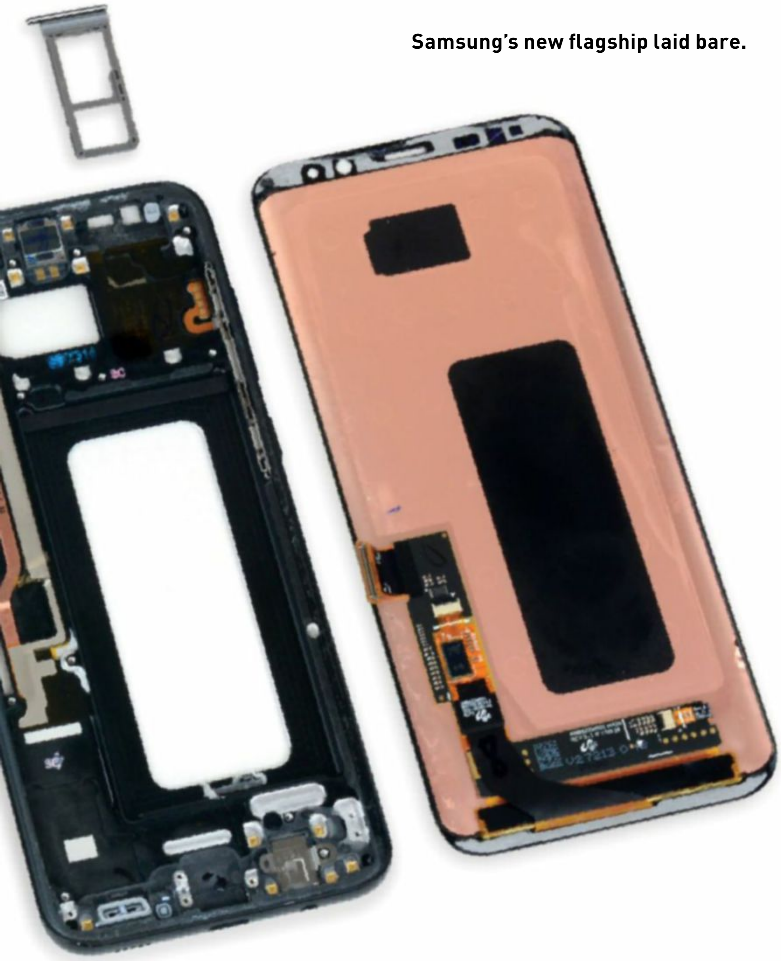
Samsung Galaxy S8+



It's not often we see such a glorious-looking cooling solution as this.

About iFixit

iFixit is a global community of tinkerers dedicated to helping people fix things through free online repair manuals and teardowns. iFixit believes that everyone has the right to maintain and repair their own products. To learn more, visit www.ifixit.com.



Samsung's new flagship laid bare.

Super-sticky adhesive makes this one tough cookie to remove.

BACKGROUND

Samsung is back, baby! The world's biggest smartphone maker has launched what is very nearly the world's biggest smartphone—with its monster 6.2-inch display, the Galaxy S8+ packs a visual wallop. But how will it fare on the teardown table? Let's get the exploded view.

MAJOR TECH SPECS

- 6.2-inch, dual-edge, Super AMOLED display with 2960x1440 resolution (529ppi)
- Qualcomm Snapdragon 835 processor, with 4GB RAM
- 12-megapixel rear camera with dual-pixel autofocus, and 4K video capture; eight-megapixel selfie camera
- 64GB internal storage, expandable via microSD card (up to 256GB additional)
- IP68 water resistance rating
- Android 7.0 Nougat

KEY FINDINGS

- Enough delay—we're eager to see inside. Luckily, by now we know the drill. Plenty of heat from our iOpener softens the adhesive enough to pry the rear glass up, and start battling our way in. But for all our talk, this rear panel does present something new. The fingerprint reader lives in the rear panel, with a very short cable tying it to the motherboard. It looks as though Samsung designed the cable to safely pull free with the rear panel. With almost no slack, the gentlest lift of the panel yanks the cable right out from its tiny pop connector. This makes it decidedly less damage-prone than certain fingerprint sensor cables we've seen before.
- Let's hope that Samsung's improved testing procedures are what the Note 7 was missing, because this design looks about the same to us. And it's still a bear to pry it off that adhesive. Even with the battery fully removed, the glue won't let go. The S8+ features a 13.48Wh (3,500mAh at 3.85V) battery—the exact same capacity as the Note 7, and a little less than the S7 Edge's 13.86Wh. Samsung continues to beat Apple in the battery capacity wars, with the iPhone 7+ weighing in at 11.1Wh (2,900mAh at 3.82V).
- We extract the I/O daughterboard. There's lots of ingress proofing in evidence, including the speaker grille surround and the seals on the USB Type-C connector and headphone jack, with a collection of gaskets that help earn the phone its IP68 rating. The headphone jack itself remains modular—good for repairability, as this is a high-wear component.
- On a hunt for the mysterious home not-button, we dig into the display, despite previous difficulties. Luckily, this fused display/digitizer peels up from its frame with a decent struggle, but no damage. Hoping to find some hidden detail under the display cabling, we peel it up and find—zilch. No model information, and no visible pressure sensor. Better luck next time.
- Repairability Score: 4 out of 10 (10 is easiest to repair). Many components are modular and can be replaced independently. The battery can be replaced, but tough adhesive and a glued-on rear panel make it unnecessarily difficult to achieve. Front and back glass make for double the crackability, and strong adhesive on both makes it tough to access the internals for any repair. Because of the curved screen, replacing the front glass without destroying the display is extremely difficult. ⏻

Advanced Kodi Tips and Tricks

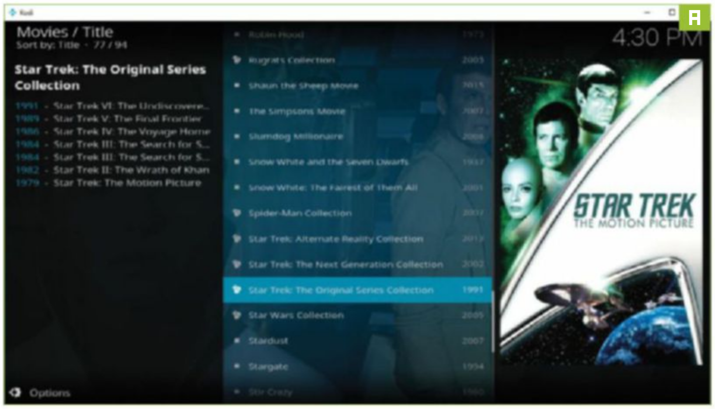
YOU'LL NEED THIS

KODI
Download from www.kodi.tv or install it through the App Store (choosing the latter option ensures that it updates automatically).

WHEN IT COMES TO CONSUMING MEDIA—movies, photos, home video, and music—on your PC, there's no substitute for Kodi. It's equally at home providing you with a big-screen friendly interface for locally stored content as streaming media over the Internet. You can—with the right help (as in this feature)—even use it as a front end for playing classic games from yesteryear.

The basics of Kodi are reasonably straightforward: Point it to your local music, movie, and picture folders, and you're good to go. That said, the user interface does come with a bit of a learning curve attached, and some of its best features are buried away behind seemingly impenetrable dialogs and settings. This, however, is where we come in.

We're going to skip the basics—adding a media folder to your library isn't rocket science, thankfully—and dig deep beneath Kodi's surface to reveal some of its best kept secrets. Everything from changing library view to auto-starting add-ons, and using Kodi as an Airplay audio receiver is covered here. Oh, and we'll show you how to name and organize your media library so Kodi's scrapers can download all that gorgeous artwork and extra info, too. **–NICK PEERS**


A
Kodi
Movies / Title
Sort by: Title · 77 / 94
Star Trek: The Original Series Collection
1991 - Star Trek VI: The Undiscovere...
1989 - Star Trek V: The Final Frontier
1986 - Star Trek IV: The Voyage Home
1984 - Star Trek III: The Search for S...
1984 - Star Trek III: The Search for S...
1982 - Star Trek II: The Wrath of Khan
1979 - Star Trek: The Motion Picture
Robin Hood
Rugrats Collection
Shaun the Sheep Movie
The Simpsons Movie
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Snow White and the Seven Dwarfs
Snow White: The Fairest of Them All
Spider-Man Collection
Star Trek: Alternate Reality Collection
Star Trek: The Next Generation Collection
Star Trek: The Original Series Collection 1991
Star Wars Collection
Stardust
Stargate
Stir Crazy
Options
4:30 PM
STAR TREK
THE MOTION PICTURE

1 EXPAND YOUR LIBRARIES

The quickest way to manage your library—and add new content (including music)—is to open "Settings," and browse to "Media Settings." From the "Library" section, click your chosen library—"Videos," "Music," or "Pictures"—under "Sources," and click the "Add" option to add another folder to your library. Remember to name your media correctly—head over to http://www.filebot.net, to grab a handy tool to help you with this.

›› While you're in the "Library" section, you can periodically clean your video or music libraries to remove files that have been renamed, deleted, or stored on a drive no longer connected to your PC, but to do this, you must first click the "Standard" setting at the bottom of the screen in order to switch to "Advanced," and reveal the cleaning options.

›› If you'd like to streamline your movie library, navigate to the "Videos" section, and flick the "Show movie sets" button to on. Now all the movies in a specific series (such as *Star Trek*, *Star Trek II*, and so on) are grouped together [**Image A**]—click the main entry to drill down to browse and play each individual movie.

2 TWEAK MUSIC INFO

Got an obscure album the default music scraper can't identify? Go to "Media Settings → Music," and click the "Default provider" option for album or artist information, then click "Get more..." to pick from a range of alternatives. And if your music has been tagged, but you'd prefer to use the information provided by your music scraper, make sure you switch to "Advanced" view, and flick the "Prefer online information" switch to on.

3 CONFIGURE LIVE TV

If you've set up live TV on your PC (or indeed any PC on your network) using TVheadend or a similar service, select "TV" from the main Kodi menu, and choose "Enter add-on browser." Locate and select your chosen PVR server, then click "Configure" to set up access (for example, to connect to a remote PVR server, enter its IP address and PIN access code). Click "Enable," and press Esc to go back to the main screen.

›› Once enabled, you'll see several widgets appear under "TV," making it easy for you to access the TV guide and previous recordings, as well as browse live TV (and radio) by clicking the remote, and choosing which channel to watch. If you've previously found Kodi unwieldy with live TV, now's a great time to try it again—you'll find the latest update has made it easier and more responsive, even when streaming over your network.

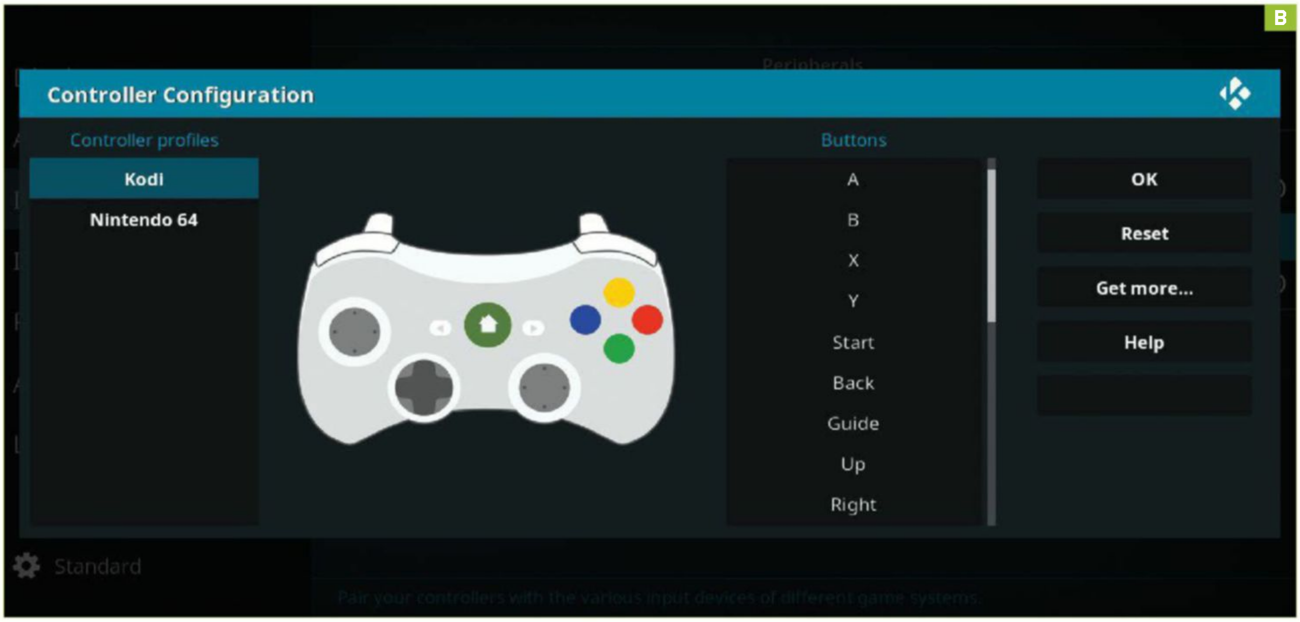
4 CONFIGURE GAMEPAD

If you're using Kodi on your gaming rig, why not use your gamepad to navigate? To set things up, simply press a button on your gamepad while Kodi is running, and it should ask if you want to configure it [**Image B**] (or you can go to "Settings → System Settings → Input → Configure attached controllers," if you prefer).

›› You'll see a default configuration—Kodi—is present. You can manually link the controls on your gamepad by clicking the buttons on the right, and following the instructions, at which point your controller should work. While you're here, why not flick the "Enable rumble for notifications" switch to on?

5 CONFIGURE KEYBOARD SHORTCUTS

It's worth familiarizing yourself with Kodi's keyboard shortcuts. There are the playback controls, for example: P to play, X to stop, left/right arrow



keys to skip back or forward 30 seconds, or R/F to rewind and fast forward—press once for 2x, then keep pressing to speed up. Or press the backslash (\) key to move between windowed and full-screen mode.

›› All well and good, but what if you don't like the keyboard shortcuts Kodi's picked, or you'd like to configure some more of your own? From the home screen, select "Add-ons," and click "Enter add-on browser." Click "..." if necessary to return to the main screen, then choose "Program add-ons," and scroll down to locate and install the Keymap Editor. Once done, click "Run," and choose "Edit" to review current shortcuts and define your own, using both your keyboard and your game controller buttons.

6

ADD A REMOTE

If you've set up Kodi in your living room, you don't want to have to use a keyboard or mouse to control it. If the game controller option doesn't appeal, simply turn your cell phone (Android or iOS) into a fully functional remote. First, you need to configure Kodi: Navigate to "Settings → Service settings → Control," and enable "Allow remote control via HTTP." Enter a username and password for security reasons—you'll need this later to set up the connection with your cell phone. Also, flick the "Allow remote control from applications on other systems" switch to on, and—if you've not already done so—switch on "Announce services to other systems" under "General."

›› Next, install either Kore (Android) or Official Kodi Remote (iOS) from the appropriate app store. iOS users can open it, tap "Add Host," followed by "Find Kodi." Enter your username and password, then tap "Save" to hopefully make contact and take control.

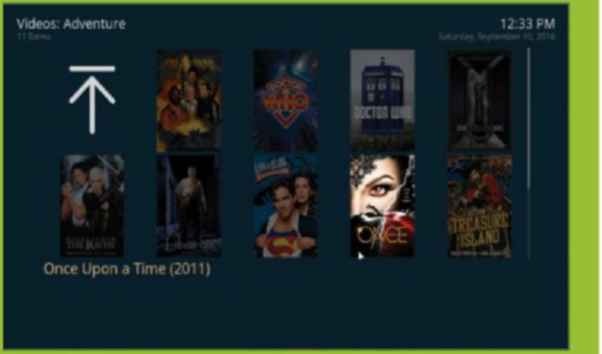
7

A CHANGE OF SKIN

Kodi 17 defaults to the Estuary skin, a big-screen friendly skin that still lacks a little oomph. If you're running Kodi on a touchscreen device, we recommend going to "Settings → Interface Settings," and clicking "Skin" [Image C] to switch to Estouchy instead—it's a similar skin to Estuary, but optimized for touchscreen devices (short tap to select, long tap to bring up the context menu for an item).

›› Alternatively, click "Get more..." to choose from over 20 more. Pining for the look of previous versions, for example? Confluence is still an option (or try Aeon Flux for a more updated approach). Visit

MAKE YOUR OWN SET-TOP BOX



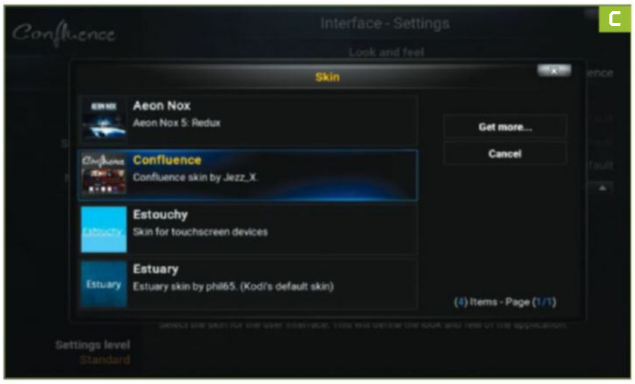
Kodi runs on Windows, Mac, and Linux, but you can also install it on your Android tablet (or jailbroken iPad), plus downloaded dedicated distros for turning a low-powered computer, such as a net-top PC or Raspberry Pi, into a dedicated Kodi set-top box.

Kodi recently dropped all support for its dedicated Kodibuntu distro, which paired Kodi with Ubuntu 14.04. Existing Kodibuntu/XBMCbuntu users should be able to update to Kodi 17.1 through the Terminal, though:

```
$ sudo apt-get update && sudo apt-get-dist-upgrade
```

If you're new to running a dedicated Kodi machine, then you're left with two choices. Raspberry Pi users are best served by OSMC (https://osmc.tv), which can also be installed on a jailbroken first-generation Apple TV. You can find links for downloading a tool to create the required microSD card on Windows, OS X, and Linux, or you can download disk images directly.

OpenElec (http://openelec.tv) provides dedicated builds for AMD/Intel-powered PCs (including lower-powered Atom and Fusion CPUs), plus the Raspberry Pi, and a selection of WeTek third-party devices, as well as Freescale iMX6 devices from the likes of Cubox.



Aeon Nox
Aeon Nox 5: Redux

Confluence
Confluence skin by Jezz_X

Estouchy
Skin for touchscreen devices

Estuary
Estuary skin by phil65. (Kodi's default skin)

(4) Items - Page (1/1)

https://kodi.tv/addons/look-and-feel/skins for a better view of how each skin looks without having to install it.

8 FURTHER CUSTOMIZATIONS

Once you've installed your new skin, you can tweak it further from the same "Skin" menu—change its theme to try a different color scheme, for example, or tweak the fonts to your personal choice. Select "Configure Skin," and you skip to the "Settings → Skin" menu, where more granular changes can be made, such as picking a different background image or pattern, selecting which libraries and other items (such as live TV) to show on the main screen, or choosing how much detail about each media item is displayed. Options vary from skin to skin—and don't always appear in the same place, so be prepared to dig deep to find them.

9 POWER-SAVING SETTINGS

If you've hooked up Kodi to your living room TV—perhaps through a dedicated computer (see box on previous page)—you should take measures to configure power-saving to both protect your TV and reduce energy consumption. To do this, go to "Settings → Power saving," and click the up arrow next to "Put display to sleep when idle," to set a delay of five minutes—you can increase this all the way to 120 minutes, but a 5 or 10-minute delay is usually best.

» If you'd like to power off Kodi after a set period, switch to "Advanced" or "Expert" view, then set "Shutdown function" to one of "Shutdown," "Hibernate," or "Suspend," before setting the "Shutdown function timer" to a delay—again between 5 and 120 minutes—based on inactivity.

10 MAKE KODI AN AIRPLAY RECEIVER

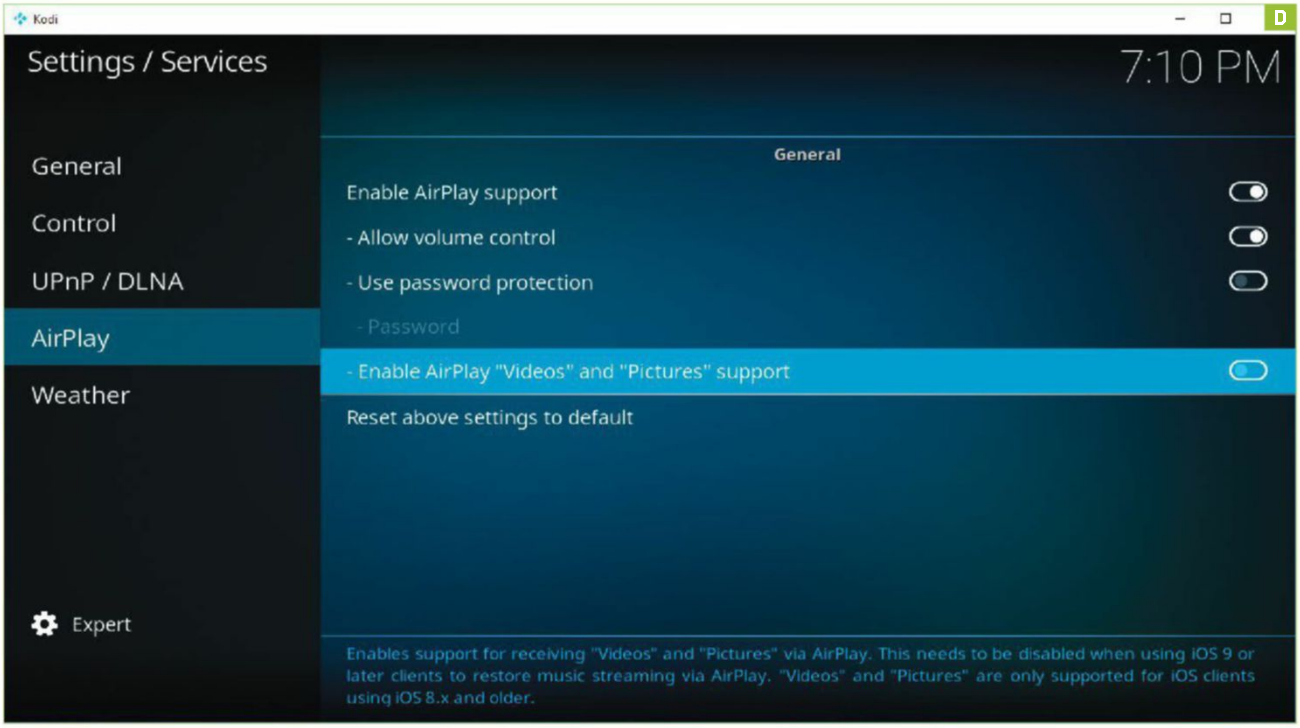
The following feature can be troublesome to set up—and frequently breaks between updates—but if you would like to stream audio from your iPhone or iPad to your PC or TV's speakers, give it a go. First, if you don't have iTunes installed on your PC, install Apple Bonjour from https://support.apple.com/kb/dl999, then go into Kodi, and navigate to "Settings → Service Settings → General" to enable Zeroconf, and review your "Device name," which is how Kodi will advertise itself on your iOS device when detected.

» Now select "AirPlay," and flick the "Enable AirPlay support" switch to on. Switch to "Expert," and you'll see a new option appear: "Enable AirPlay 'Videos' and 'Pictures' support" [**Image D**]. This needs to be switched off for AirPlay to work with devices running iOS 9.0 or later. Once done, you should find Kodi appear in the list of AirPlay devices on your iOS devices.

11 ADD ADD-ON REPOSITORIES

Some of the best Kodi add-ons aren't bundled with the official repositories (repos)—to get those, you need to install additional repos. This is slightly fiddly, but once you know how, it's reasonably straightforward. For the following example, we're going to add the Fusion repo.

» First, go to "Settings → System → Add-ons." Flick the "Unknown sources" switch to on, and make a note of the warning. Next, go to "Settings → File Manager." Double-click "Add Source" on the left, then click "None" to bring up



General

Enable AirPlay support

- Allow volume control

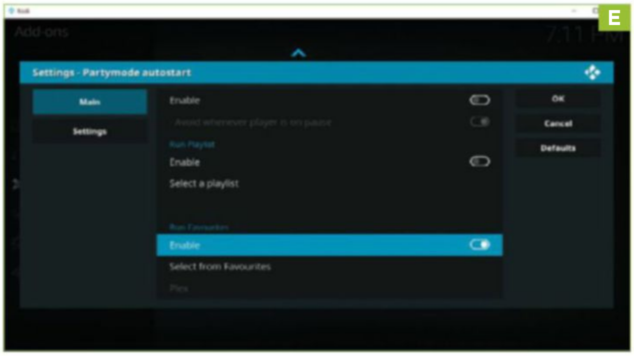
- Use password protection

- Password

- Enable AirPlay "Videos" and "Pictures" support

Reset above settings to default

Enables support for receiving "Videos" and "Pictures" via AirPlay. This needs to be disabled when using iOS 9 or later clients to restore music streaming via AirPlay. "Videos" and "Pictures" are only supported for iOS clients using iOS 8.x and older.


E

the virtual keyboard (which you can ignore). Type the following web address, and click "OK": http://fusion.tvaddons.ag

» Name the source "Fusion" and click "OK." Next, return to the home screen, and click "Add-ons." Click the box icon in the top-left, and choose "Install from zip file." Scroll down, and select "Fusion" from the list, then browse to "kodi repos\english," where you'll see a host of available repos to choose from. Select a zip file, and click "OK" to add that repo to your list. Now, when you open "Add-ons → Download," you'll find additional add-on choices in each category.

12 REMOVE REPOS

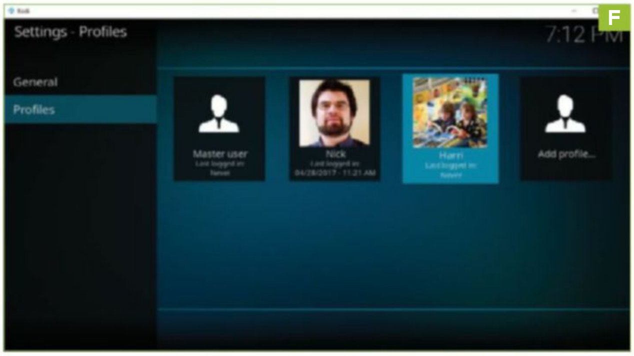
Third-party repos are by their nature risky, and can contain dangerous material (see http://kodi.wiki/view/Banned_add-on for a list of so-called "banned" repos—Fusion is one of these). If you decide a repo isn't for you, remove it. Go to "Add-ons → My add-ons → Add-on repository." Click the unwanted repo to bring up its window (you can configure its update settings from here, too—for example, switch between auto and manual updates). To remove it completely, click "Uninstall." Close and restart Kodi.

13 AUTOSTART ADD-ONS

Here's the scenario: we've got a Raspberry Pi set up to exclusively run the Plex add-on in Kodi. We want to autostart Plex with Kodi to save the hassle of manually accessing it from the main menu. You can autostart add-ons using a script, but a simpler way is to use the Partymode Autostart add-on [**Image E**].

» Add your add-on to the "Favorites" menu: Browse to "Add-ons," then locate your add-on (Plex in our example). Right-click it and choose "Add to Favorites." Go back to the main "Add-ons" screen, and choose "Downloads → Services," where you'll find Partymode Autostart. Once installed, right-click it, and choose "Settings."

» Under "Main," enable it to "Run on Startup," and reduce the delay to 0 seconds. Make sure "Run on Screensaver" and "Run on Playlist" are disabled, then scroll down, and enable "Run on Favorites," before clicking "Select from Favorites" to choose your add-on. Click "OK," exit, and restart Kodi. The normal menu should briefly appear, but then your add-on should kick in. Job done!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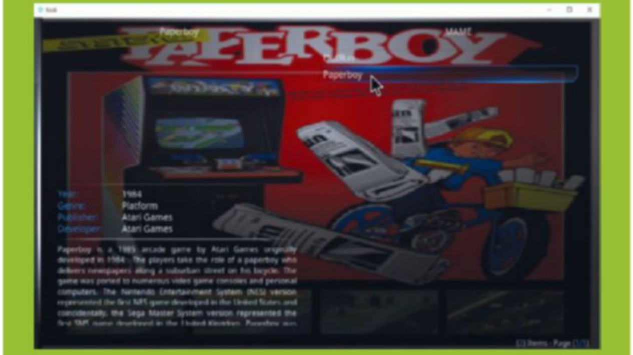
PLAY GAMES THROUGH KODI



The Rom Collector Browser add-on enables you to transform Kodi into a hub for playing games as well as accessing your media. It supports standalone games as well as emulator ROMs—these need to have been configured already (for example, through a GUI-friendly MAME variant, such as MAMEUI: www.mameui.info).

Assuming these are all in place, go to "Settings → File Manager," and choose "Add Source" to create a source pointing toward your game emulator folder (or parent folder, if multiple emulators are installed). Now install the Rom Collector Browser add-on via "Add-ons → Download → Program add-ons." Once installed, launch it, and choose "Yes" to create a config file. Choose the online option, followed by your platform, before pointing the add-on to the emulator program folder containing your ROMs and artwork folder in turn. Once done, you can include additional ROM emulators if required, before reviewing the import settings, and clicking "Import Games."

The scrapers aren't always accurate, so you may want to reconfigure Rom Collector Browser: Press the C key to bring up a menu, then select "Edit Rom Collection" to make changes.

14 MULTIPLE PROFILES

This tip will appeal more to those who use Kodi on a shared device, such as a Pi connected to your TV. Go to "Settings → Profile Settings → Profiles" [**Image F**]. Click "Add profile." Type a name, and click "OK." Leave the profile directory as it is (click "OK" again), then choose whether this profile shares the same media library as the default user (choose the read-only option to stop people from modifying the library), as well as its media sources, then click "OK." You can then opt to copy settings across from the default user or let them start from scratch.

15 LOCK DOWN PROFILES

You may not want your users to be able to tweak settings, in which case, select the profile lock option, and—if necessary—set a profile lock password when prompted: either a numeric PIN, a full-text password, or even a gamepad button combo. Make your choice, then choose what parts of Kodi to lock (effectively disabling them), from libraries (music, videos, pictures, programs & scripts) to the file manager, settings, and add-on manager. When locking settings, you can allow users to access some settings by choosing a level (standard, advanced, or expert). ⏻

Play with Digital 3D Modeling Clay

YOU'LL NEED THIS

SCULPTRIS ALPHA 6
Download this free app from http://pixologic.com/sculptris/.

THERE ARE PLENTY OF WAYS to be creative in the 3D realm, but few of them emphasize the creativity part of the equation as well as Sculptris does. Made by developer Pixologic, the company behind high-end 3D modeler Zbrush, it is, as its name suggests, primarily focused on sculpting. You're given a big ball of digital clay, then you can poke, prod, and pull it into just about any shape you like. Obviously, being based on a malleable, tangible material, Sculptris is best used to create organic shapes and creations; slashing out the slick lines of a high-end sports car is going to be rather difficult.

It's not flawless, either. There will be times when you push your clay outside the realms of normal three-dimensional physics. You might create so many polygons that your PC grinds to a halt—a decent amount of RAM and a capable graphics card is definitely recommended. But careful application of its tools and liberal use of the undo shortcut should be all you need to create something very cool indeed. **–ALEX COX**

1 GET STARTED

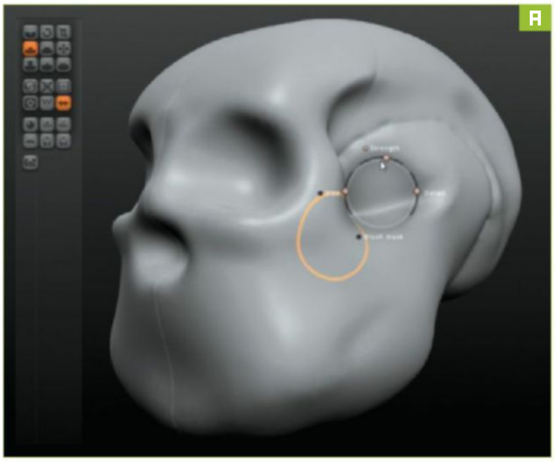
Your first few steps in Sculptris really couldn't be much simpler. Find the installer at http://pixologic.com/sculptris/, and download it. You're asked to give up a bit of personal info to get the link, but you don't explicitly have to—the link isn't sent to your email, so lie if you must. Install it, run the software, and you hit the interface. Tools at the top-left, settings for the current tool running along the top of the window, and a big ball of gray clay slap bang in the middle, ready to be molded by your mouse, with a line of symmetry running down its center. Give that clay a click right now. The default tool, and one you'll come back to again and again, is "draw," an additive tool that essentially dollops a little more clay on top of whatever you're working on—the area you clicked, highlighted by the orange circle, should grow a little. Hold down Alt and you invert the draw tool, and scoop away clay instead; this switch between additive and subtractive modes is true of just about every tool in Sculptris's palette, with a couple exceptions.

2 CAREFUL DOES IT

You may have noticed that the draw tool is a little trigger happy at this point. Using it leads to you adding or removing gigantic handfuls of clay, rather than performing the intricate molding you might be expecting. This is actually fine, because a real clay sculpture is generally made by lumping balls of material together, then smoothing them down later on. So use it, sparingly, to rough out the vague shape of the thing you're trying to create. There are only 11 undo levels stored, so be careful; you'll want to use small strokes rather than just holding the left mouse button and scribbling, but give yourself enough breathing room to take back mistakes. You can rotate your model by holding the right mouse button and dragging, pan by doing the same thing with Alt held, or zoom with the mouse wheel.

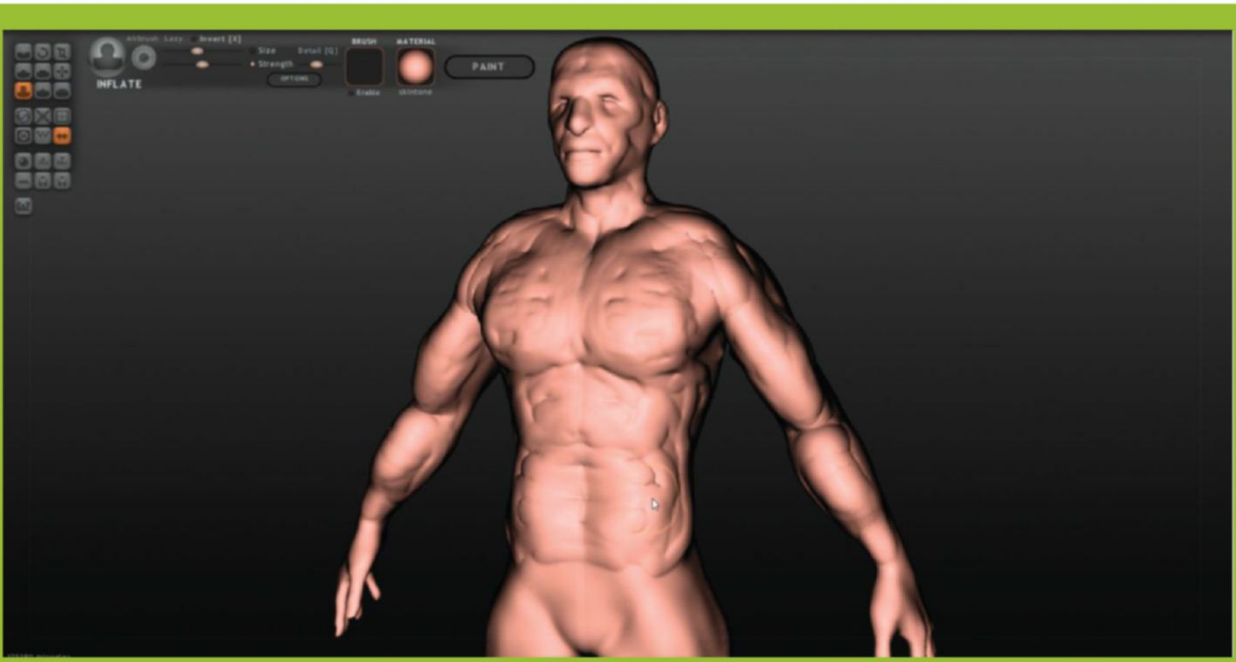
3 TWEAK THE TOOLS

This brings us to a curious feature of Sculptris's interface. Although zooming brings your model closer in view, your tool remains the same size, meaning that you can now add finer details. This is certainly one way to get intricate, but you need to use the sliders for more pinpoint control. Size, as you might expect, alters the radius of the circle of influence, again maintaining the relative size from your viewpoint, even as you zoom, while strength tweaks the amount that the tool affects your model. We generally recommend using lower strength values where possible—the more gentle you are, the less likely it is that Sculptris will place a stray vertex somewhere it shouldn't be, and cause you problems down the line. Hit Space to bring a quick slider control up close to your cursor.



4 SMOOTH IT OUT

You've added lumps, and by now you'll have created a rather rough outline of the object you're trying to create. You can now use two tools to refine your broad shape into something more workable: smooth and flatten. The former is accessible no matter what tool you have selected. Simply hold Shift to quickly switch to it (or awkwardly select it from the tools panel, though this is a much less efficient way of quickly prototyping your mold), then click and drag over your model to even out any rough edges. Again, this benefits from a lower strength, which you can set independently from the strength of your current tool, and it's worth noting that you can't invert the smooth tool with Alt to make things rougher, because that would be silly. Flatten is a slightly more extreme tool, and one you'll use less often—click a surface, and drag the circle over a higher or lower area to even things out to match the level of the surface on which you began your click.



IMPORT AND ALTER

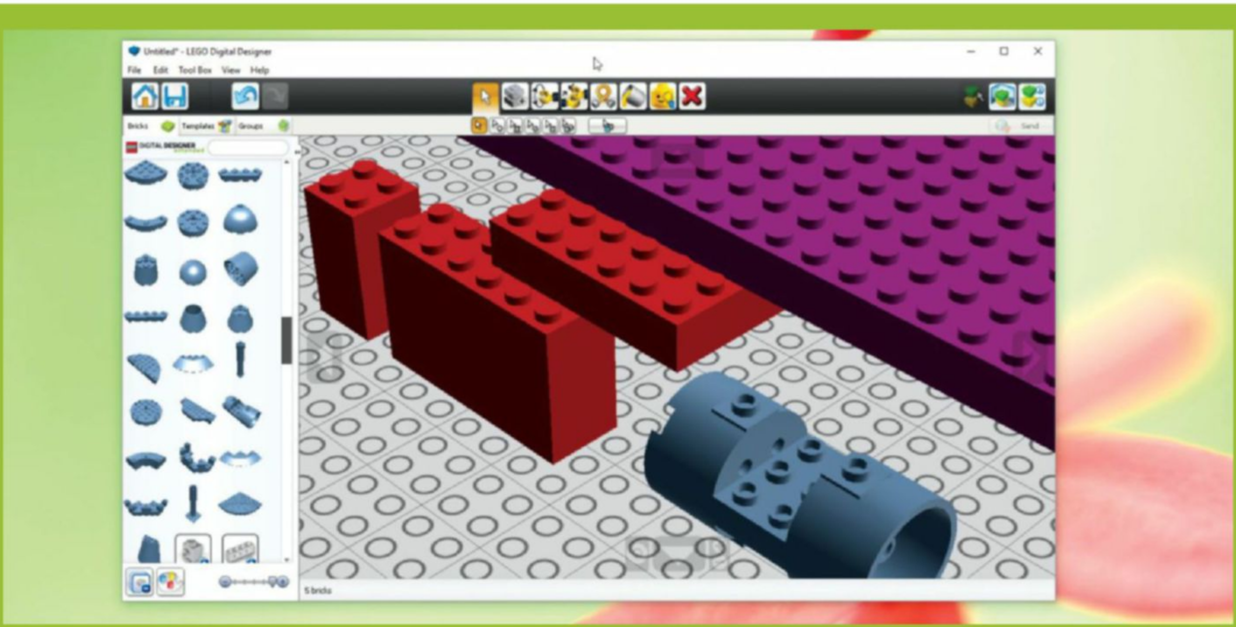
Sculptris outputs in the widely-used OBJ file format, and can import OBJ files, too. At least, it can import most of them—it complained at us if the models entirely consisted of four-sided polygons or quads, so bear that in mind. If you don't want to start with a simple blob of clay, you can base your creations on an imported model. Hit the import OBJ button, and pull in something you've downloaded from the likes of http://. free3d.com. If you don't want to increase the complexity of your model while working, set the detail slider to zero, as it is by default—these models are usually constructed to use the bare minimum of polygons, though, so you'll likely want to up the detail if you're making significant changes. If you're only looking to play with Sculptris for a bit of fun, this is a great way to get started.

5 CREASING UP

The crease tool, which we've used to add the cracks between the plates in our skull [Image A] is—despite our over-enthusiastic use of it here—probably best left alone until the end of proceedings for two key reasons: It's primarily a detail tool, and it doesn't play nice with smoothing. This means it'll be the most prominent cause of vertex errors in your model, and once they're there, they're nigh on impossible to get rid of. If you must use it, pick a low strength and a large size, and crease gradually. The same goes for the pinch tool, which isn't exactly a reverse crease—it behaves slightly differently, pulling your drawn bumps into more prominent ridges, but it's still dangerous.

6 MASKING OFF

Sculptris's rather vague, flamboyant circle of influence can be rather frustrating; editing one thing can lead to changes in other areas of your model. For our alien's (rather frightening) teeth, we've avoided this by using a mask, highlighting the area we want to work on, and eliminating others. Before you go masking, though, it's important to know that the mask brush does, by default, actually add polygons to your sculpture in order to cut off precisely the area you wish to work on. It doesn't change its form at all, but it usually increases the overall complexity of your model. To prevent this, drag its detail slider to

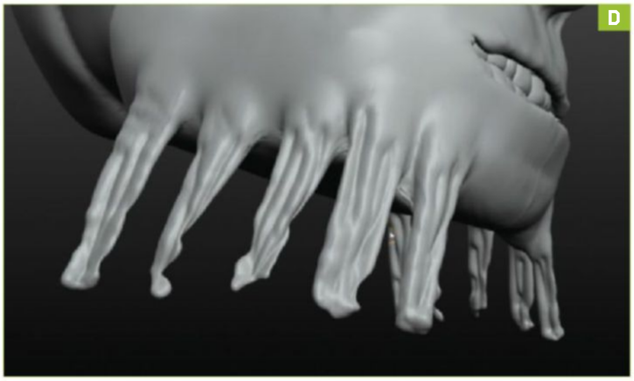

Untitled* - LEGO Digital Designer
File Edit Tool Box View Help
Bricks
Templates
Groups
5 bricks

OTHER FREE OPTIONS

While we do love Sculptris, its not been updated for a while, and it's still floating around in its alpha form, meaning there are quite a few bugs. Luckily, if you want to play with 3D, you're not limited to pro-level packages, which typically cost upward of $500. Windows 10's Creators Update, for example, introduces Paint 3D, a simplistic take on modeling, which lets you chuck around primitives and crudely inflated 2D sketches. On the other end of the complexity scale, you could try apps such as venerable open-source subdivision modeler Wings 3D (www.wings3d.com), or even the excellent modeling portion of Blender (www.blender.org). And if you're really only in this to play, the infinite building blocks of LEGO Digital Designer (http://ldd.lego.com) could be just the 3D toybox you need.

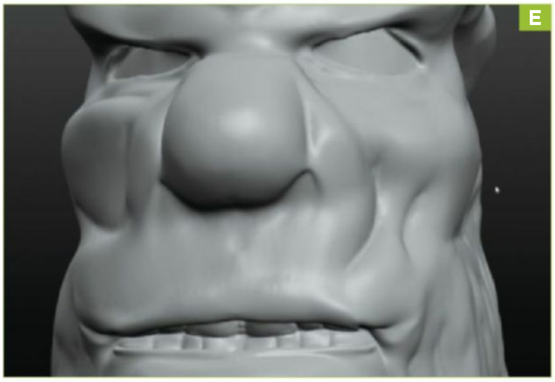
zero—now it's restricted by the polygons you have already defined. The same is true for any of the tools we might use.

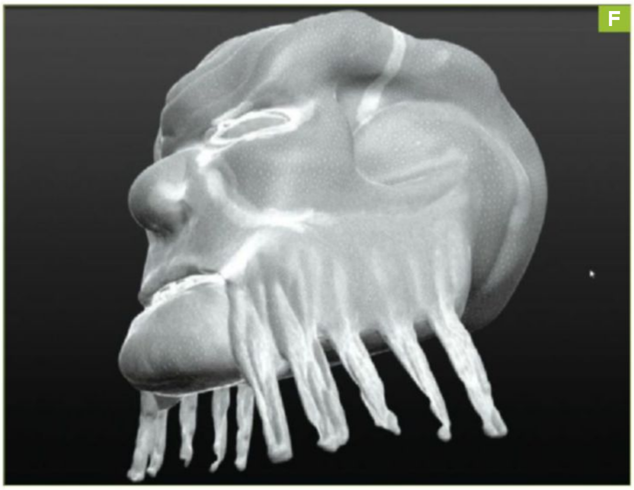
›› In our example [**Image B**], we've masked the whole head off, and left only the mouth region open for editing. You can do this by selecting the mask brush, holding down Ctrl, and clicking the background to invert the current mask. Because the whole model begins unmasked, the entire thing now becomes masked. Now, hold down Alt while drawing with the mask brush to invert it, essentially unmasking the bits you want to work on. You don't need to go this extreme, though; unless you foresee your cursor flying all over the place, a simple ring around an object you'd like to edit, or a mask over a bit you've just got right—such as the eyes [**Image C**]—should suffice. When you're done masking, hold down Ctrl, and drag the background to reset the mask to defaults.



7 GRAB & GO

If you want to make interesting effects, the grab tool is for you. It enables you to pull your material, but it's not entirely realistic—you can drag clay from a single point without necessarily distorting your whole model, for a start. So why, if it's so useful, have we waited until now to mention it? Well, grabbing and masks go very well together. Mask off an area, and start pulling the clay around it—again, being gentle, gradually tweaking using small motions, and moving the camera to give you the perfect angle—and you can create, for example, worryingly ugly lips. Mask off two sides and pull, and you can create fins or other flappy extremities, which can later be grabbed, with the correct combination of tool settings, to be angled




F

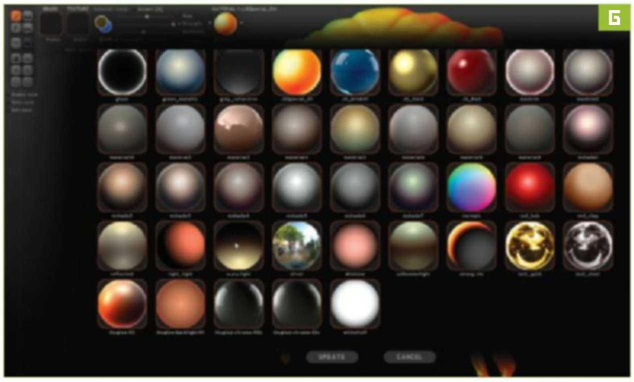
or curved. Don't think you have to use masks, though; for our alien's jaw-tentacles [**Image D**], we used the grab tool set on high strength, with a fairly narrow size, gradually pulling each longer and longer. It's hard to get too precise with this tool, so it's handy to use it in places, like our deliberately floppy tentacles, where Bob Ross-style "happy little accidents" enhance the look rather than ruining it.

8 TOUCHING UP

The next step takes as long as, or possibly longer than, the initial molding phase. It's time to get deep: Zoom in, and start adding details. Use the draw tool, close up, with a narrow focus and medium strength, to add bumps and ridges, quickly smoothing them down to give extra life and dimension to your model. Go wild with the crease tool, adding wrinkles and blemishes. When you're happy that the symmetrical features of your model are complete, hit the symmetry button to edit each side individually—it's a one-way process, so only do this when you're sure you don't need to mirror anything. You can now work on the center line of your object, which is tricky with symmetry active, and add individual features, such as scars [**Image E**]. Bear in mind, if you're creating a face, a bust, or an unpleasant alien guy, that no face is actually symmetrical, so use the grab tool with a wide radius and a reasonably low strength to shift elements around. Make one eye very slightly lower than the other, tweak the nose, use this opportunity to add expression to your face. We masked off the eye area to pull the brow down slightly, making our visage slightly more threatening.

9 SIMPLIFY IT

It seems counter-intuitive after all the fine features we've added, but the next step is to remove detail. As you construct, you'll notice the number in the bottom-left of the Sculptris window go up. This is counting the number of polygons used in your model; the higher it is, the greater the impact it has on your system. Switch on wireframe mode [**Image F**], and you'll see the truth within your creation. That rounded, soft clay isn't curvy for nothing. Deep white strips of polygons generally follow areas of heavy creasing (we told you it was dangerous), and you may even find heavy clusters of triangles where there's no reason for a big patch of detail. So leave wireframe mode active, and grab the reduce brush tool. Start gradually reducing the detail in those over-complex areas, and watch the polygon count drop as you do so. Holding the mouse button and scribbling doesn't work with this tool—it's more like the flatten tool, in that you should begin your swipe on an area of lower detail, and drag it over higher detail areas to bring them back into line.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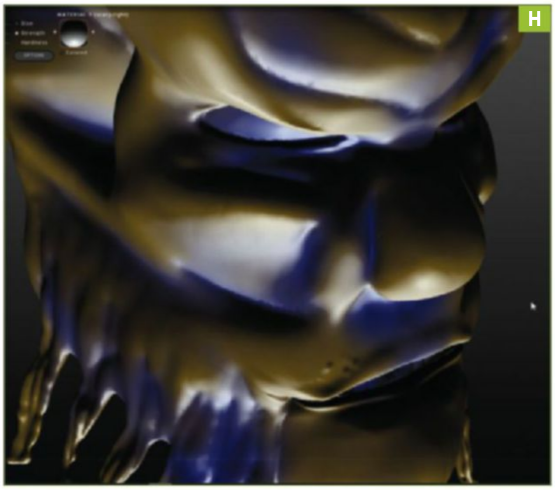

H

10 PERFECT PAINTING

Time for another one-way process: Once you're sure you've completed the sculpting portion of your model, you can transfer into paint mode by clicking the paint button at the top of the interface. It's not entirely one way—you can jump back to your model later, and add small bumps and features within paint mode, but if you start modeling again, you lose any painting you've done. Sculptris's painting tools are not its finest feature, but they're a good way to make your model more presentable before you share it with the world. The first thing you need to do is choose a base material for your model [**Image G**], by clicking the sphere toward the upper-right of the interface. There are tons to choose from, which give different levels of reflectivity and lighting, so try a few. You can choose to inherit the color as well as the light mapping of your material by toggling the option below the sphere.

›› Now comes the painting part. Begin daubing away with the paint color tool at a high strength, and you quickly find it's like attempting to apply make-up with a broom—the accuracy isn't there. You can drop the strength and, by clicking the button above the tool settings, switch on airbrushing for a more subtle effect, but it's difficult to create something that doesn't look silly, particularly if your early sculpting put a few polygons out of place, making coloring them in illogical or impossible. The best use of the paint tool is to bring out the cracks and crevices in your model [**Image H**]—paint it one uniform color, perhaps with the fill tool, then airbrush its valleys with a darker color, using the cavity button to pick them out specifically. ⏻

Create Bokeh Effects Using Photoshop

YOU'LL NEED THIS

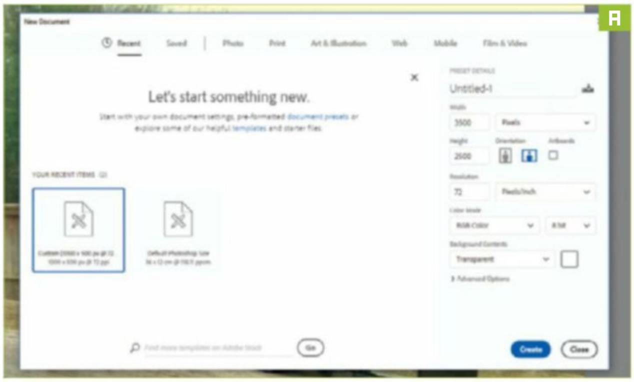
PHOTOSHOP
Subscribe to various Adobe packages at www.adobe.com.

A PHOTOGRAPH
One taken on a smartphone or compact camera would make the most of the effect.

BOKEH IS THE NAME GIVEN to the perceived quality of the out-of-focus areas of a photograph. More generally, it's used to refer to those areas themselves, the word coming from the Japanese for blur or haze. The effect is most easily created using a digital SLR camera, with a large sensor and a lens with a large aperture and long focal length, creating minimal depth of field in the photo, and throwing the background completely out of focus.

In this situation, highlights in that background tend to become more prominent, changing from points of light to large hazy circles, sometimes taking on characteristics of the lens, such as a particular shape, or picking up on aberrations within the glass. Done right, it can be beautiful.

It's an effect that's difficult to create with a compact camera or cell phone, because despite the larger apertures creeping into smaller cameras' lenses, the tiny sensors and incredibly short focal lengths work against you. Luckily, it's completely possible to fake a bokeh effect with a little Photoshop know-how. **–IAN EVENDEN**



Let's start something new.

Untitled-1

3500 Pixels

2500

72 Pixels/Inch

RGB Color

8 bit

Transparent

1 CHOOSE YOUR BACKGROUND COLOR

As is often the case with Photoshop, there's a couple of ways to go about this. Firstly, we'll fake a completely new background for our image. Take a look at the photo you want to use—what are the main tones in the background? We've taken a photo of a graphics card sitting on a fence outside, for obvious reasons, so the background is a mix of greens, light browns, and muddy hues. We can sample these later, so don't worry too much about them for now, but choose one to act as the main background color. Use the Dropper tool to sample it, and set it as your background color by clicking the little right-angled arrow next to the color samples on the left, below the toolbar.

2 MAKE A NEW BACKGROUND

Create a new document [**Image A**], and make it roughly the same size as your photo (you can find out its pixel dimensions by going to "Image → Image Size"). In "Background Contents," change from "Transparent" (the default) to "Background Color." Click "Create," and you should get a new document completely filled with your sampled color. Save it as a PSD, then create a new layer in the "Layers" palette.

3 CREATE A CIRCLE OF COLOR

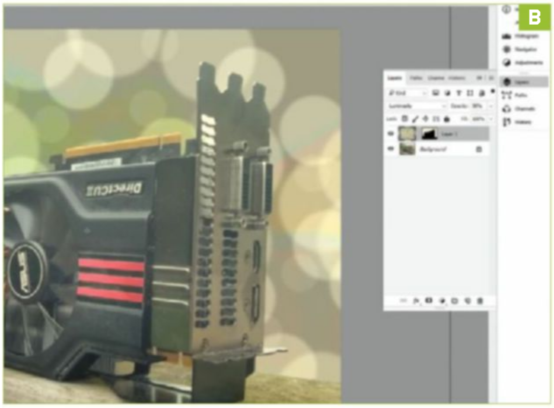
Go back to your original photo, and sample another color from the background. This time, keep it as your foreground color. Go to your new document and, on the new layer, use the Elliptical Marquee tool to create a circle (hold Shift to constrain it, because you'll end up with an oval otherwise). Feather the edges of your selection by 10 pixels using "Select → Modify → Feather," to keep the transition between colors soft, then fill the circle with your foreground color using the Bucket tool. Deselect, and you end up with a circle of color with a soft edge.

4 TWEAK THE CIRCLES

Duplicate this a few times, using the Move tool in conjunction with Alt, and hit Ctrl-T to enter "Free Transform" to resize your circles. This way, each circle sits on its own layer. Once you've made enough circles, group some together by grouping their layers (blend them first, so they show through where they overlap—"Screen" works well) to make duplication easier. Again, use "Free Transform" to resize and rotate the groups.

5 BLEND THE BACKGROUNDS

When happy, merge all your layers, and head over to the original photo. Select the background, feather the edge by a few pixels, and drop your new image into the selection using "Edit → Paste Special → Paste Into." Use "Free Transform" again to size it to fit, then blend it with the original background using "Luminosity" [**Image B**], but keep it at about 97 percent. This allows a bit of color graduation, but doesn't allow background detail through.

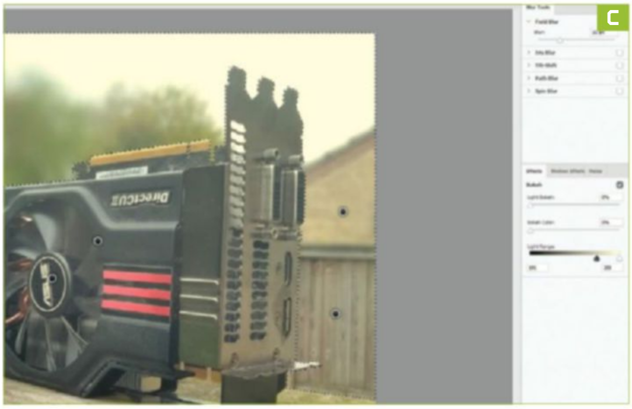


6 BLUR METHOD

An alternate method is to use Photoshop's Field Blur filter, to adjust the level of blur depending on how far away background objects are from the camera. Select the background as you did previously, then open "Filter → Blur Gallery → Field Blur." Your cursor now turns to a rather unhelpful push-pin shape, and a circular target appears in the center of your image. What you're going to do is drop pins into different areas of the image, then control how blurred they are by using the sliders on the right-hand side. It works best if you choose objects in the order in which they recede from the camera. So, our first pin goes on the graphics card itself, with the blur slider set to zero. Next, we drop a pin on the bit of fencing on the right of the card, then the fence to the left, which is further away, then the house beyond that, on the right, then the trees in the far background, increasing the amount of blur each time [**Image C**]. Photoshop is intelligent enough to make a good guess at what you want to blur, by selecting continuous areas of color for you.

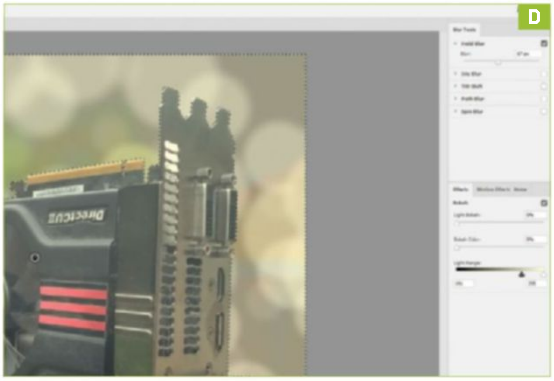
7 FURTHER BLURRING

Below the blur sliders is another set, marked "Effects," and you can use these sliders to alter the blurred areas further. We found Light Bokeh to be the most effective slider, creating a nice bloom effect in the background highlights, but it's also the easiest to take too far, rendering unnatural white spots in the soft blur. Once you're happy, hit "OK."



8 FINAL TOUCHES

If you want, you can combine both techniques we've covered here, and create a really defocused background with specular highlights, and an increase in blur as distance from the camera increases [**Image D**]. The important thing is to keep the selection of your foreground object saved, using "Select → Save Selection," so it can be loaded back again at a later time, saving you the bother of having to make the selection all over again. Once you're happy, save the PSD for further tinkering later, and export your image as a JPG or PNG for sharing or printing.



BLUR

Filters to blur images made up some of Photoshop's earliest tools, and the new Blur Gallery does much to bring them up to date. Motion blur can add a sense of movement to photos of, for example, mountain bikers, while the Path Blur tool enables you to blur along lines in an image, which is perfect for adding movement to the arms of dancers. Converting the layer you are working on to a Smart Object (right-click it in the "Layers" palette) enables you to add effects without making them permanent—perfect for experimenting. Even on a normal layer, the "History" palette enables you to step back through your work, and undo anything you don't like.

Play VR Games on Your Cell Phone

YOU'LL NEED THIS

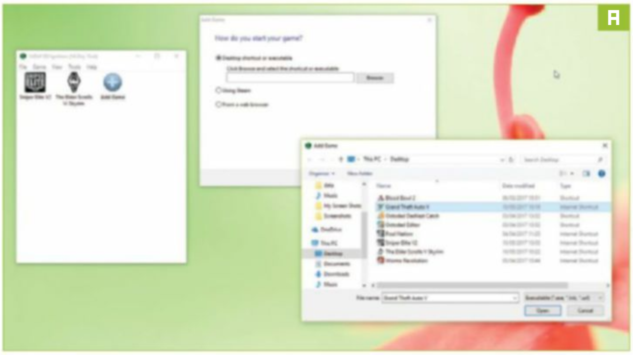
TRINIUS VR
PC server (www.trinusvr.com) and Android app (Play Store).

TRIDEF 3D
Grab the 14-day free trial from www.tridef.com.

CELL PHONE HEADSET
From Google Cardboard up.

WE DON'T ALL HAVE AN EXPENSIVE VR HEADSET. Without one, exploring the three-dimensional world of the future is sadly out of reach. But we do, in the most part, all own cell phones, which means that world is a lot closer than you might think. With a $15 plastic headset (or even a cheap and cheerful Google Cardboard) and a little software trickery, it's actually pretty straightforward to start exploring VR gaming without the need for an Oculus Rift or a Vive. And with the software we've selected here, you're not even tied to those games that have VR support built in.

Time for a little tempering of expectations, though, as there are certain things that VR on your cell doesn't do nearly as well as VR on a dedicated headset. We've rooted out the most lag-free method possible, but those nanoseconds of delay are definitely there. Head tracking works, but you can forget about room-scale interaction. And your cell phone's screen may not be the ideal candidate for being an inch from your eyes; we noticed a lot of rainbow edges and screen door effect while testing this guide. Forgive those few flaws, though, and you're in for quite a ride. **–ALEX COX**



1 GET PREREQUISITES

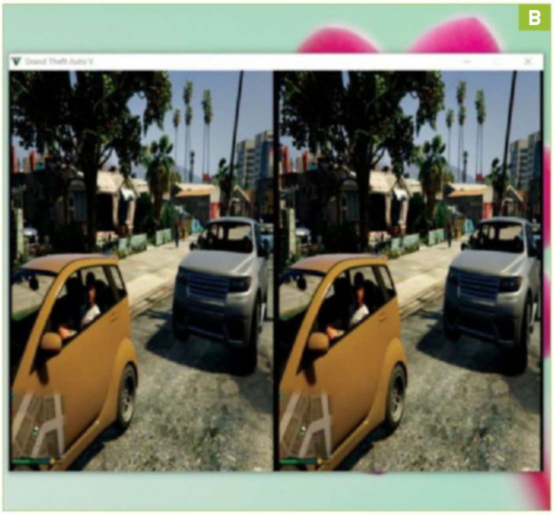
We're using a pair of software components for this tutorial. First is TrinusVR, which comes in two parts: a PC server (get it free from www.trinusvr.com), and an Android app (available from the Play Store in 15-minute trial mode, which you should install first, and in a time-unlimited $9.99 full version). We've selected Trinus over some of the other options (VRidge, in particular) because it's not picky about which games it runs; its competitors generally do the job of translating already VR-compatible titles from their Oculus or Vive modes into a stream displayed on your Android headset, but don't run with anything else. Trinus includes a fake 3D mode, which attempts to translate any 3D game into one that's VR-compatible, but it doesn't actually add any noticeable 3D—which is where TriDef 3D (get the 14-day free trial from www.tridef.com before you drop $39.99 on the full thing) comes in. This app intercepts the z-buffer of a host of popular games, such as *Skyrim, GTA V,* and over 900 others, outputting a stereoscopic view with real depth. The two running in parallel offer just the thing we're after, although it's worth noting that you can also use Trinus to run SteamVR games without the need for TriDef 3D.

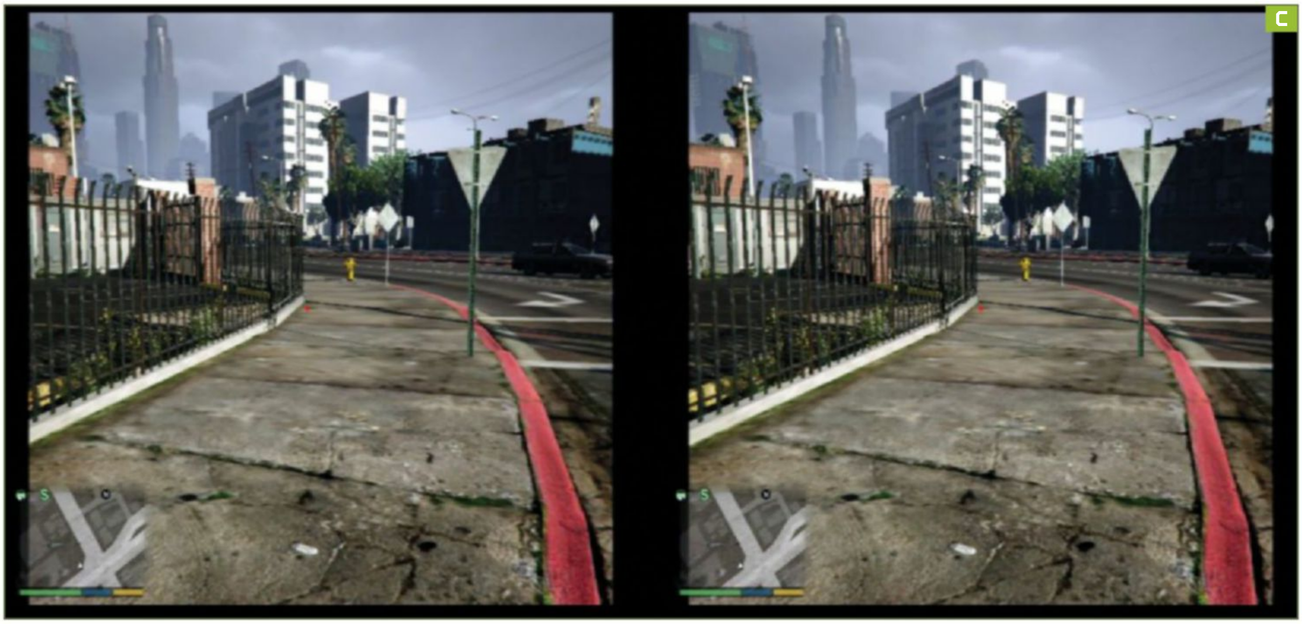
2 HOOK IT UP

With everything installed, it's time to tether your phone to your PC via USB. Depending on your handset, this is either trivially easy or teeth-gnashingly hard, but it's absolutely worth doing, particularly if your phone has USB 3.0 support. In theory, you just need to head to your Android settings screen, select "More" under "Wireless & Networks," head into "Tethering & Portable Hotspot," then flip the appropriate switch. Our test phone cryptically insisted we first switch off both Wi-Fi and cell data before we could set up a tether; your results may vary.

3 RUN IN STEREO

Run TriDef 3D, and head to the "Play 3D games" option to escape its awful initial menu. It may have found some games installed on your system already, but its detection routines aren't the sharpest; to add a new title from its supported list (www.tridef.com/user-guide/supported-games), double-click the "Add Game" icon, click "Add a game manually," then point it to the desktop shortcut of your chosen title [**Image A**]. Select the game's name from the next window, and its icon ends up in the TriDef interface. Double-click it to get the game running, and set that game to run windowed in a 4:3 resolution, such as 800x600 or 1024x768, with low-level anti-aliasing. If all has gone well, you'll see a split-screen view of your game on your desktop [**Image B**].





4 START STREAMING

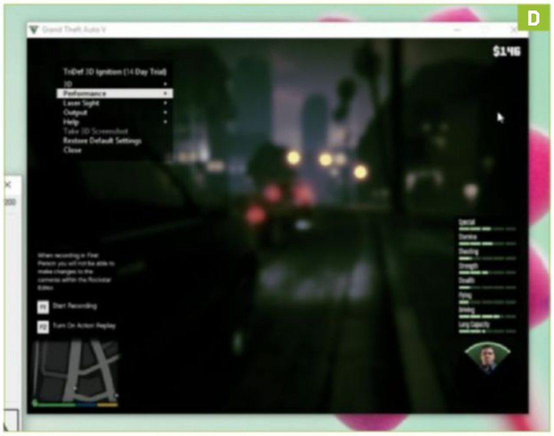
Now open up Trinus on your desktop and phone. They should each, if correctly tethered, say "USB detected." On your desktop, head to the "Video" tab and set "Fake 3D" to "Disabled," then set the capture mode to "General" in the "Main" tab. It's now time to test your connection—hit the triangular icon on each app to establish the connection, click your game window to bring it into focus, and your game should appear on your cell screen [**Image C**]; slide your handset into your VR headset, and you're ready to play.

5 REFINEMENTS

Your initial experience might be a bit fuzzy. By default, Trinus doesn't apply any lens correction, meaning certain areas of your game window are out of view, and you may experience a very compressed image. Let's make this better: Click the triangle to cancel the connection for now, then, on the "Main" tab of the Trinus desktop app, set the image scale to "Ultra," and drag the compression slider all the way to the right. Under "Head mount," tell it which headset you're using, then head to your cell phone, open the settings screen, switch "Lenses" on, and set the performance to "Quality." Connect again, and you'll find things are much sharper; with lens correction on, you should see a less distorted picture, with most of the UI in view—or at least you will once you view your cell screen through your VR lenses.

6 ADDING DEPTH

With your game running, hit 0 on your number pad to see TriDef's on-screen display [**Image D**]. You can tweak a number of options using the 8, 4, 2, and 6 keys to navigate, and 5 to select. With your headset on, use the 3D menu to tweak the scene depth to your liking, but bear in mind that pushing it all the way to 100 leads to some odd shimmering shadows around certain objects in the middle distance. You can also adjust the amount that's pushed in front of your screen, essentially using an inverse stereoscope, although this can be taxing on the eyes, so use caution here. If your GPU can handle it—and, let's face it, the low definition of phone screens means we're not pushing the resolution here—up the quality to "High" in the performance menu.



ANTI-NAUSEA TECHNIQUES

If you experience discomfort or sickness while using this guide, there are a few things to try. First, check your headset; if you can adjust the focal length and width of your lenses to suit the width of your pupils, do so. Then use the "IPD" slider on Trinus's main tab to adjust it in software—you can scroll with your mouse wheel to get it just right. Next, head to the "Sensors" tab, and adjust the sliders to increase or reduce the feedback your cell's gyro gives to Trinus. Head tracking is a tricky thing to nail down, and finding the sweet spot here should make your experience a lot more comfortable. You may or may not find that setting a dead zone, reducing wobble in-game, helps slightly, and sensor prediction can make a small difference if that tiny amount of lag gives you an out-of-body experience. The most important advice we can give, though, is to stop using VR if it's making you feel sick. However fun it may be, it's not worth losing your lunch over.

BUILD IT

ALAN DEXTER, EXECUTIVE EDITOR

Ryzen to the Challenge

Just because AMD's new chips offer great value for money, it doesn't mean we have to scrimp and save

LENGTH OF TIME: **2-3 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

WE'RE ALWAYS COMPARING hardware here on *Maximum PC.* Every review, build, and feature sees us comparing components, or whole systems, against what has gone before; either explicitly when picking components, or more subtly when alluding to performance metrics. Even so, it's rare that we actually go head to head against another machine in the same issue, yet that's exactly what we're doing here: two machines aimed at solving the same problems, but only one can be considered the winner.

That's the ethos behind the cover feature this month, and to some extent, that forms what has gone into these two builds. However, when it comes to piecing together this Ryzen build and the Intel one on page 70, they can be considered in isolation. If you want to build either machine, you'll find the full component lists and build processes over the next few pages, and you don't have to keep referring back to the cover feature in order to do so.

Having said that, there are a few things worth bearing in mind at this point: These machines are designed to handle workstation loads, and, as such, the component choice isn't the standard desktop fare—the Radeon Pro WX 7100 that can be found inside this machine is aimed at serious CAD work, for instance, not playing the latest games at 4K. With that said, it's time to get building....

STARTING ON THE RIGHT FOOT

OBVIOUSLY, THE STARTING POINT for this build was the Ryzen 7 1800X, the high end of AMD's current Ryzen lineup. We did briefly toy with the idea of trying to build a machine on a much tighter budget, to see what sort of value for money we could squeeze out of AMD's new architecture, but looking at the Intel rig that Zak's piecing together, cost is clearly the last thing on the young reviewer's mind. Time is money, after all. Once we'd decided on the chip to use and the general ethos of building something that needs to at least give Intel's finest a run for its money, a lot of the other components came together quite easily.

On the motherboard front, we went for the winner of last month's AM4 motherboard group test, the MSI X370 Gaming Pro Carbon. Into that we slid four 8GB sticks of Corsair's sleek Dominator Platinum RAM, alongside a serious graphics card in the form of the AMD Radeon Pro WX 7100. There are plenty of all-in-one solutions for keeping a Ryzen cool, but here we wanted to go with an air cooler, and so reached out to Arctic, who provided us with a Freezer 33 for our build. We've used the same hard drive and M.2 system drive as the Intel machine, which give us a good base for a fast boot drive, coupled with plenty of space for data at the same time. We eased all of this gorgeous gear into the spacious Corsair Carbide Air 740 case, and powered it all with the frankly over-the-top HX1200i Platinum from Corsair as well.

INGREDIENTS

PART		STREET PRICE
Case	Corsair Carbide Air 740	$132
Motherboard	MSI X370 Gaming Pro Carbon	$173
CPU	AMD Ryzen 7 1800X	$465
Memory	32GB (4x 8GB) Corsair Dominator Platinum 2666	$299
GPU	AMD Radeon Pro WX 7100	$625
PSU	Corsair HX1200i Platinum	$208
Storage 1	Samsung 960 Pro 512GB PCIe NVMe SSD	$328
Storage 2	Western Digital Black 2TB 7,200rpm HDD	$118
Cooling	Arctic Freezer 33	$43
OS	Windows 10 Home 64-bit OEM	$100
Total		$2,491

1

INSIDE OUT

THERE ARE TWO schools of thought when it comes to building PCs: check the core components outside of the case first, and the more optimistic route of throwing it all together in the chassis, and only finding out if you've got problems once you flick the switch. For this build, we were of the more pessimistic persuasion, partly because our chip had some bent pins that needed straightening. It also means you have lots of room when piecing together the cooler. The Arctic Freezer 33 was fairly straightforward, as it uses the backplate that comes with the mobo. Even so, we ran into a few problems while screwing in the heatsink, which resulted in a screw sheering. We had a spare backplate, but if you're not so lucky, don't force it. Like we did.

2

ROOM FOR POWER

WE LOVE COMPARTMENTALIZED CASES, because they promote good airflow and clean builds, and the Carbide Air 740 gives you plenty of space in both sections for your components. The rear area is for the power supply and your hard drives, with removable drive cages for 3.5-inch and 2.5-inch drives. There is ample space for the slightly oversized power supply we used in this build, and the fact that it is completely modular made for a particularly easy installation. A thumbscrew helps position the PSU in place with a tiny retaining bracket, as you get it lined up with the rear grille, which is a neat addition.

3

CAPACIOUS INTERIORS

SLIDING THE MOTHERBOARD into place was every bit as easy as installing the power supply. In fact, because the PSU is in its own compartment, it frees up plenty of space around the motherboard, making this one of the easiest installs we've ever done. After clipping the rear IO shield into place, the board slotted in neatly. One thing to note here is that we had to spin the rear case fan around, so that it was working in tandem with the Arctic Freezer 33, as opposed to fighting against it. We could have avoided this by installing the cooler fan the other way around, but we didn't want to obstruct the RAM slots, despite there being plenty of clearance.

4

SMALL SCREWS

ONCE THE MOTHERBOARD was in place, it was a straightforward task of installing the memory and the M.2 drive. The only awkward bit here was getting the heat spreader, that MSI includes to keep those M.2 temperatures in check, screwed into place. This uses a very small screw, which escaped our grasp a few times when trying to anchor it in place. In hindsight we should have installed the M.2 drive before placing the motherboard in the case. It's also worth noting that we're using the top M.2 slot, as there are two slots on this motherboard.

5

CABLE GUY

THE NEXT STEP was to spin the case around so we could work on the cabling after installing the hard drive. The Carbide Air 740 uses a tool-free design for holding your hard drives, which means that popping the data drive into the system was really easy—clip the drive into the caddy, then slide it into the cage. There's only room for three 3.5-inch drives in this cage, although there's space for four 2.5-inch drives as well. Cabling was also straightforward, thanks to the copious number of rubber-edged cutouts on the motherboard tray.

6

SINGLE SLOTTER

THE RADEON PRO WX 7100 is something of an oddity in these days of over-sized coolers, because it's just a single-slot card. There's an air of no-thrills seriousness about its design, and it's refreshing to not have to worry about making room for a two- or three-slot behemoth. The card only requires a single six-pin power connector, too, which was easy to route around the back of the motherboard. We connected the rest of the cabling at this point as well, pulling it as tight as possible around the back to keep airflow clear on the business side of things—particularly important when using an air cooler on the CPU.

RADEON PRO WX7100
msi

① Having the hard drives and power supply in the back compartment makes for a clean build, with plenty of room around the motherboard for good airflow, while providing easy access to the various ports. All the cutouts make for some neat cabling options, too.

② The Arctic Freezer 33 was straightforward to install, and kept the Ryzen 7 1800X at comfortable temperatures in use. You may get a little more overclocking headroom with an all-in-one water cooler, but the simplicity of this solution is a good counter to that.

③ A professional card, such as the AMD Radeon Pro WX 7100, isn't essential for many builds, and if you fancy spending your spare time gaming, an enthusiast-level card may well be a better option. For instance, an RX 580 is half the price, and outperforms it when it comes to gaming.

THE EVERYMAN WORKHORSE

THE BIG SELLING POINT OF RYZEN is the multi-threaded performance at a great price. This machine promotes that ethos in a succinct way without compromising in order to get its point across—you could definitely build a cheaper workstation with the same core, but it wouldn't be as rounded a machine. This is a PC that has an eye on its price tag, while knocking out solid performance at the same time.

The build itself was surprisingly straightforward, with the Corsair Carbide Air 740 making for a great basis for a clean build. After constructing so many ITX systems, it's refreshing to have so much room around the motherboard. If you're going to augment your own workstation with plenty of SSDs and hard drives, this comes heartily recommended—although if you want to install lots of 3.5-inch hard drives, you're going to need to come up with your own mounting system, because the included cage only holds three drives.

The other component that impressed us was the Arctic Freezer 33. Even allowing for the fact we overtightened one of the mounting screws, and needed to grab another backplate, we'd still class it as an easy install. (Besides, that was our fault, not Arctic's.) The Arctic Freezer 7 Pro was an incredibly popular option back when the Core i7-920 was king, and while it's doubtful that the Freezer 33 will regain the throne in these days of all-in-one coolers, it's worth considering for your own builds.

When it came to testing, we could have left the Ryzen 7 1800X running at stock speeds, but that would have felt like we were wasting the chip's true potential. We couldn't get this particular chip running at 4GHz stably (it would boot fine, but then fall over during a hearty benchmarking session), so settled for a solid 3.9GHz instead. There is an argument to be had for not overclocking at all when dealing with a workstation, but it's in our DNA to push CPUs as hard as possible, and we weren't about to change that stance. Even so, for reference, we did initially run the chip at stock settings, and saw Cinebench R15 post scores of 149 in single-threaded loads, and 1,600 with the multi-threaded test.

It's worth bearing in mind that this is our standard benchmarking suite for Build It, and as such it leans toward gaming more than the hardware in this machine is happy with. The Radeon Pro WX 7100 is essentially an RX 480 with slightly slower clocks, which equates to a rather sound thrashing from our zero-point machine (which employs a Fury X for the gaming heavy lifting). You can hit smooth frame rates in most games with some tweaking, but if you're serious about relaxing with your workstation, you would be better off going with either a more powerful card, or conversely a cheaper one. To find out more about the workloads that these machines are really built for, we suggest turning to our cover feature on page 26. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	987	1,710 (73%)
Cinebench R15 Single-Thread	196	158 (-19%)
CrystalDisk QD32 Sequential Read (MB/s)	1,895	3,509 (85%)
CrystalDisk QD32 Sequential Write (MB/s)	949	2,093 (121%)
Rise of the Tomb Raider (fps)	76	32 (-58%)
Far Cry Primal (fps)	72	56 (-22%)
Attila: Total War (fps)	42	28 (-33%)
The Division (fps)	73	56 (-23%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM. All games are tested at 1080p on max settings, with HD texture packages installed.

BUILD IT

ZAK STOREY, REVIEWS EDITOR

The Intel Rig of Damnation

Proof, once and for all, that X99 is the platform-pulverizing workstation of choice

LENGTH OF TIME: **2-3 HOURS**

LEVEL OF DIFFICULTY: **EASY**

THE CONCEPT

THIS IS IT: the head-to-head. The build-off. To hell with gaming, it's Ryzen versus Intel. X370 versus X99. Chipset versus chipset. A superstar competition to determine the definitive champion of the workstation marketplace. Whether it's photo manipulation, 4K video editing, or the most advanced calculative tasks, we're pitting two of the gnarliest top-end Ryzen and Intel systems against each other in an epic battle to the FPU death.

After spending the last few issues gushing over Ryzen's positive performance prowess, it was this hardware reviewer's duty to take on team blue for our challenge. And, boy, did we call in the big guns: 10 cores, 20 threads, 64GB of high-spec DDR4 memory (we did consider 128GB but, well, we can't absolutely demolish the competition), an Nvidia GeForce GTX 1080 Ti, and Asus's now legendary X99-E-10G WS motherboard to hold the whole thing together.

From a price to performance perspective, this is a system and a platform that makes little to no sense. With Intel's chips still priced so ridiculously high compared to their red counterparts, the per core cost of this machine really is unjustifiable. That said, with support for twice as much memory, at frequencies as high as 3,333MT/s, and with the vast majority of rendering programs benefiting from larger quantities of the volatile stuff, it should make this platform the overall performance king.

THE KING OF CRAZINESS

OK, THAT PRICE: OUCH! Why the big bucks? Where are the compromises? And what makes this system so much better than the $2,000-cheaper competition fielded by executive editor Alan Dexter (pg. 66)? That X99 platform. Knowing the Intel build was never going to win as far as affordability was concerned, we decided our best bet was to leverage those two extra cores and the greater support for DDR4 than the X370 opposition. By default, our Ryzen system consisted of an eight-core, 16-thread processor, and 32GB of DDR4, likely operating at 2,133MT/s, depending on motherboard revision. In contrast, we doubled the memory capacity to 64GB of 3,200MT/s DDR4, and added an extra two cores and four threads. Couple all that higher-spec quad-channel memory with the more powerful cores, and our real-world benchmarks should be substantially different from the Ryzen cousin. Enough to shatter those real-world benchmarks in half? You'll have to read our lead feature (pg. 26) to find out.

Apart from memory and chip differences, the two rigs feature identical storage setups. To retain parity, we decided to run each system off a single Samsung 960 Pro 512GB PCIe M.2 NVMe SSD, and a 2TB WD Black hard drive—we didn't want the storage to have a huge impact on the real-world figures. Couple that with the fact that the X99 smokes X370 on the number of SATA ports and potential PCIe drives, and you can see what we're getting at.

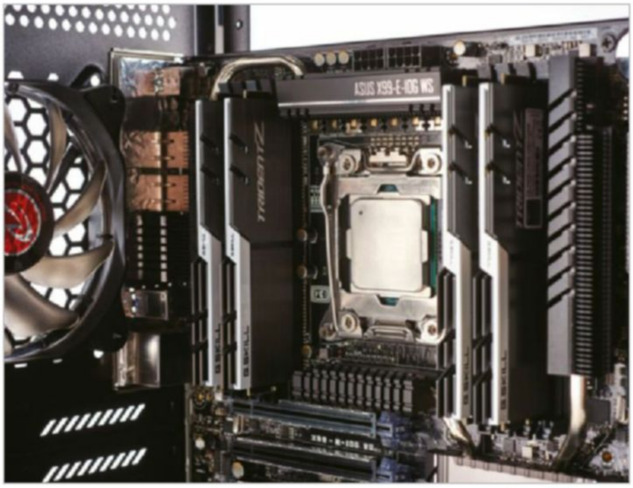
INGREDIENTS

PART		STREET PRICE
Case	Raijintek Asterion Plus	$140
Motherboard	Asus X99-E-10G WS	$640
CPU	Intel Core i7-6950X	$1,600
Memory	G.Skill Trident Z 64GB (4x 16GB) DDR4-3200	$600
GPU	Zotac GeForce GTX 1080 Ti 11GB Founder's Edition	$679
PSU	EVGA SuperNova T2 1,600W 80+ Titanium	$385
Storage 1	Samsung 960 Pro 512GB PCIe NVMe SSD	$328
Storage 2	Western Digital Black 2TB 7,200rpm HDD	$118
Cooling	Noctua NH-D15 CPU heatsink	$89
OS	Windows 10 Home 64-bit OEM	$100
Total		$4,679

1

MOTHERBOARD MOUNTING

AHH, THAT BEAUTIFUL X99-E-10G WS. To be quite honest, we could have gotten away with a cheaper motherboard, but we simply had to request this one back in. The connectivity, combined with its strong overclocking prowess and workstation pedigree, made it the perfect choice. Also, the beauty of X99 is its lack of need for a backplate. We simply installed the motherboard into the system, popped the memory and chip in, and could leave the massive CPU heatsink until last, thanks to that reinforced socket, making life a dream in comparison to our Ryzen competition.



2

FANS WITH MOLEX?

RAIJINTEK'S ASTERION PLUS comes with an assortment of cooling from the get-go—pretty impressive for this kind of chassis. And those fans? Well, they're not bad either. You get two 120mms in the front, and a single 120mm in the rear—the only nuisance is those Molex adapters. Traditionally (well, back in the late noughties), if you didn't have enough fan headers on your board, you could plug them in via Molex, to get them to run at a constant speed. However, because we didn't need them, we simply cut the Molex part off as close to the three-pin header as possible, and plugged the fan header into the board instead.

3

PSU PROBLEMS

IT'S BEEN A STRUGGLE to find a system in which we can use EVGA's 1,600W T2—without occupying those PCIe slots with another three GTX 1080 Tis, there's very little need for a PSU of this caliber. However, the biggest problem by far isn't the fact that it remains heavily under-utilized, but more that the thing is so darn long. So long, in fact, that it ends up touching the hard drive cages located under the PSU cover, even in this rig. It's a frustrating fix, but for the sake of the build, as we're only running one hard drive here, we opted to pull the hard drive cage out entirely, and run off the single one on top of the PSU cover. In a real-world scenario, you could get away with running a 1,200W PSU or smaller, then keep the additional HDD cage, to allow for a total of three 3.5-inch HDDs.

4

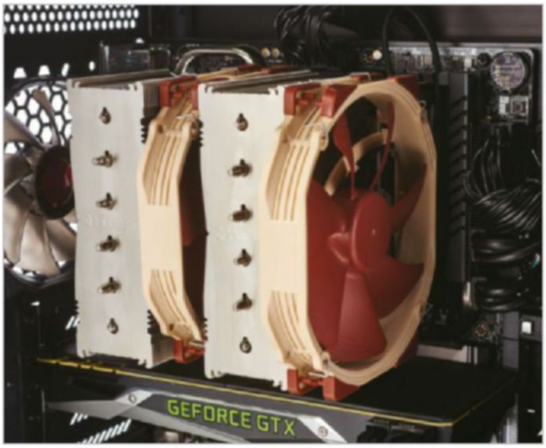
HARD DRIVE SOLUTIONS

AND HERE'S OUR SOLUTION to the conundrum we mentioned above: You can mount an additional two SSDs here, on top of the PSU cover—or, using the included rubber locking grommets, a single 3.5-inch HDD. You need to use a straight SATA data cable, and the end of a SATA power, but it's more than suited to chilling out here. Let's just take a moment to appreciate that Samsung 960 Pro 512GB—we do enjoy some of that sweet M.2 love. What a standard!

5

NOCTUA COOLING SUPERCOLLIDER

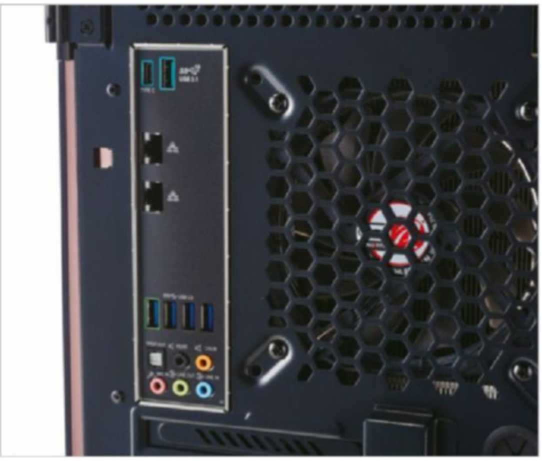
NOCTUA'S NH-D15 is a monster of air cooling capability. With two NF-A15 140mm fans, it cools the same surface area as a Kraken X62 or Corsair Hydro H115i AIO. But with two major differences: It works by convection, not a pump, and is half the cost of the Kraken. And with Noctua's legendary fan lifetime (150,000 hours), and six-year warranty, there's no fear of it dying on you. But it wasn't all roses: We had to raise up the closest fan to avoid making contact with the memory, and drop down the GTX 1080 Ti by one PCIe slot, so it didn't make contact with the GPU's backplate.

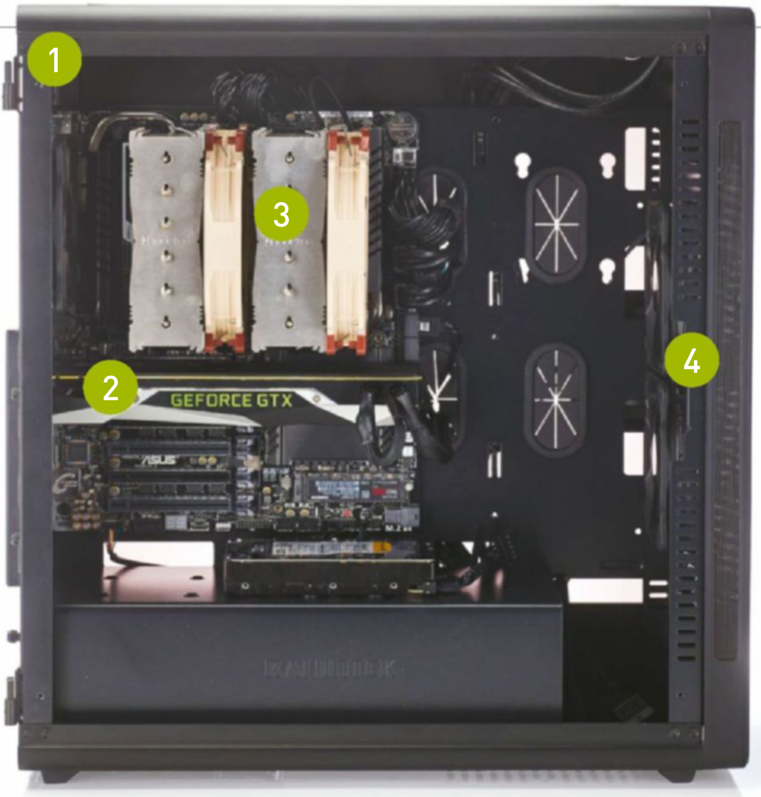


6

LIMITED I/O

LOOK AT THAT REAR I/O, or perhaps we should say lack of. There's not a lot of it on this board. Four USB 3.0 slots, one USB 3.1 Type A, and another Type C, and, of course, the standard 5.1 + optical-out audio solution. But the real kingpin of this device is the dual 10Gb/s Ethernet ports, and a fairly good excuse for skimping on the internal storage. Couple this system with a QNAP TS-431X-2G NAS, with built-in 10GbE, for a $350 starting price, sans hard drives, and a nice chunky 10GbE Internet connection, and it would be a workstation force to be reckoned with.





1 The biggest fault with this case is probably the rear panel, consisting of a hinged acrylic door—if your cable tidying isn't good enough, it'll jut out above the hinges.

2 We could have gone with a Titan XP, or perhaps even a Quadro, but for most jobs, the GTX 1080 Ti holds its own against the two graphics giants, and comes in far cheaper.

3 Although appearances shouldn't really be a major factor when it comes to a decent workstation, we've got to admit that the beige and poop-brown fans have really grown on us.

4 If a windowed chassis like this isn't your jam, you could save yourself some cash, and opt for a silenced Fractal Design Define R5 midi tower instead.

PRICE VS. PERFORMANCE

THIS BUILD WAS A RELATIVE cake walk to produce. There were conundrums and problems that needed solving, mostly to do with that insane NH-D15 cooler being a little too chunky in various places, but otherwise nothing really stood out in terms of difficulty. Ideally, we would have loved to have gone with a case with a touch more storage potential, but you should be running your backups away from your main system in this working environment anyway. Replace that meager 2TB with a 6TB or higher WD Black, and it should be plenty for any onsite storage.

The biggest advantage of using the X99-E-10G WS, however, comes in the form of those dual 10GbE connections in the back. What they do is make offsite storage a potential reality for heavily accessed programs and media. That QNAP NAS we spoke of earlier, coupled with a few HDDs, would make this system truly killer. On top of that, if you really do crave the internal capacity, there's support for a total of six 2.5-inch drives with this system, all of which can be plugged in via the X99-E-10G's 10 SATA 6Gb/s connection. And, of course, you have Intel's U.2 connector, and that M.2 x4 for a plethora of PCIe alternatives.

On to performance. Because we've already covered our extensive real-world tests in the main feature (pg. 26), we'll focus on the usual plethora of system benchmarks here, to provide some clarity for the regulars about how our two systems perform.

In short, and unsurprisingly, our Intel system absolutely demolishes our zero-point in almost every benchmark, the big one being Cinebench R15. Our 6700K, at 4.6GHz, is certainly no slouch, but can it compete with the mastery of a 4.2GHz Core i7-6950X? Sadly not. With the 20-threaded beast bringing in an impressive 2,188 points in multi and 175 points in single-core performance, it makes the 6700K look like small change.

Storage performance was equally as impressive, with the 512GB Samsung 960 Pro booting those figures up against the wall. Our 1080p gaming test suite also fell prey to the 1080 Ti, with nothing scoring below 60fps.

The biggest shocker, however, was the cooler, and its absolutely staggering performance. Staying at a steady 72 C, with 1.29V in the V Core, the plucky tower just goes to show that not only can you overclock easily enough on air, but it's just as powerful as any AIO, and packs the extra reliability that a pump simply cannot muster.

There's no escaping the fact that this system is expensive—exceedingly so—but if you're after the very best in performance, whether that's for 3D rendering, video content creation, photo manipulation, or more, in this humble reviewer's opinion, X99 is still the king of the hill. Well, until Skylake-X and that luscious new chipset drop later on in the year, at least. ⏻

BENCHMARKS

	ZERO-POINT	
Cinebench R15 Multi-Thread	987	2,188 (121%)
Cinebench R15 Single-Thread	196	175 (-11%)
CrystalDisk QD32 Sequential Read (MB/s)	1,895	3,450 (82%)
CrystalDisk QD32 Sequential Write (MB/s)	949	1,951 (106%)
Rise of the Tomb Raider (fps)	76	92 (21%)
Far Cry Primal (fps)	72	121 (68%)
Attila: Total War (fps)	42	65 (55%)
The Division (fps)	73	131 (79%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our desktop zero-point PC uses a Core i7-6700K CPU @ 4.6GHz, an AMD R9 Fury X, and 32GB of RAM.
All games are tested at 1080p on max settings, with HD texture packages installed.

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REVIEWS

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AOC AGON AG251FZ PAGE 86

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INSIDE

76 AMD Ryzen 5 1500X
78 Gigabyte Aorus Radeon RX 570 4GB
80 HP Z2 Mini G3
82 Asus ROG Rampage V Edition 10
85 Intel Optane M.2 32GB PCIe 3.0 x2 NVMe Cache
86 AOC AGON AG251FZ
88 Logitech G413 Carbon
89 Corsair Glaive RGB
90 Yooka-Laylee
91 The Signal From Tölva
92 Lab Notes

AMD Ryzen 5 1500X

Can Ryzen maintain the magic with four cores?

MORE CORES, more threads, and more performance for less money. That's the killer proposition for AMD's new Ryzen CPU. Suddenly, most of Intel's desktop processor range looks overpriced and short on punch.

But does that thinking extend to this, the new Ryzen 5 1500X, with its mere four cores and eight threads? After all, Intel has plenty of mainstream quad-core chips to choose from. And as good as Ryzen undoubtedly is, Intel still has the edge on a per-core basis.

Initially, the 1500X looks competitive, if not quite the knock-out option of the six and eight-core models. At $189, it lines up roughly against the Intel Core i5-7400. That's a quad-core, quad-thread model, with a 3GHz base clock and 3.5GHz Turbo speed. Ryzen chips aren't directly comparable in terms of clock speed, but with a 3.5GHz base clock and 3.7GHz turbo speed, the 1500X has a little extra in hand to offset Ryzen's slight per-clock deficiency versus Intel's finest. It's also fully unlocked, theoretically allowing for even more frequency advantage where Intel keeps most of its chips locked down, bar the pricey K series models.

Of course, you could argue that if you're going with Intel, you would be crazy not to grab the Core i5-7500 for just $10 more, what with its 3.4GHz base clock and 3.8GHz Turbo speed. And as we'll see, it's just that kind of calculation that eventually undoes the 1500X. But that's getting a little ahead of ourselves.

First, let's have a sniff around the 1500X's prowess in our performance benchmarks. Like the other Ryzen chips we've sampled, multithreading is where it hits hardest. At over 800 points in Cinebench, it batters the much more expensive Intel Core i5-7600K, let alone those cheaper Core i5 models. The 1500X is quicker than the 7600K in Fry Render, too, albeit by a pretty small margin, though it's more or less a dead heat in x265 video encoding. In other words, it'll absolutely beast those price-parity Core i5-7400 and 7500 processors in anything that's multithreaded.

BEATEN AT ITS OWN GAME

The exception, as ever, is gaming. Many titles tend to be GPU-limited at the detail and resolutions keen gamers are likely to be using. But where a game is CPU-limited, which is the case even at high resolutions in *Total War: Attila,* Intel chips still have the edge, though it's worth noting that this quad-core Ryzen delivers precisely the same frame rate in *Attila* as the six-core 1600X. Over time, as game developers get their heads around the nuances of AMD's new Zen architecture, the gap may well narrow. For now, though, gaming is Ryzen's one obvious weakness, and it applies to the 1500X as much as any other mode.

Gaming, however, really is the exception. Nearly everywhere else, Ryzen is damn quick. The 1500X also impressed, in relative terms, in our overclocking tests. We managed a straightforward and stable 4.1GHz, or a 400MHz overclock. That's not exactly spectacular, but it's a useful 10 percent boost.

So the question you have to ask yourself is whether the $30 saving over the six-core Ryzen 1600 and the $60 saving versus the slightly faster 1600X is worth it. With the latter, you're getting both 50 percent more cores and slightly faster clocks. What's more, with any Ryzen processor, you're almost certainly going to need a new motherboard and RAM to go with it. That means a likely minimum investment in the region of $500. In that context, an extra $30 or $60 for a six-core model and a lot more performance is surely the better choice.

With all that in mind, it's not the Intel alternative that pulls the rug out from under the 1500X, it's the value proposition of those six-core models. A few years down the road, when some of us have existing systems with AMD's new AM4 socket, the value calculation will look different. But for now, and considering the total cost of going with a new Ryzen rig, this particular 1500X chip is a hard sell. –**JEREMY LAIRD**

VERDICT
7

AMD Ryzen 5 1500X

+ **SLICK 'N' QUICK** Faster than comparable Intel chips for multithreading; unlocked for overclocking.

– **NOT SO TRICK** Not a compelling value proposition; sub-par gaming performance.

$189, www.amd.com

BENCHMARKS

	Ryzen 5 1500X	Ryzen 5 1600X	Intel Core i5-7600K
X265 (fps)	15.85	**22.18**	15.86
Cinebench R15 Single (Index)	154	159	**179**
Cinebench R15 Multi (Index)	807	**1,223**	663
Fry Render (Seconds)	329	**226**	346
Power Draw Idle (Watts)	**42**	45	44
Power Draw Load (Watts)	**101**	115	103
Total War: Attila (fps)	36	36	**40**
Far Cry Primal (fps)	75	74	**77**
Rise of the Tomb Raider (fps)	**43**	**43**	**43**
Deus Ex: Mankind Divided (fps)	**13**	**13**	**13**

Best scores in bold. Our test bed consists of an Asus Crosshair VI Hero, 16GB of Corsair Vengeance LPX DDR4, and a GeForce GTX 1080. Games are tested at 1440p on the highest graphical profile, with MSAA enabled.

SPECIFICATIONS

Base Clock	3.5GHz
Turbo Clock	3.7GHz
Cores	4
Threads	8
Lithography	14nm FinFET
Cache	16MB
Memory Support	DDR4 2400
Memory Channels	2
Max PCIe Lanes	16+4+4
TDP	65W

AMD Ryzen 5 1500X
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Ryzen's value proposition isn't quite so killer in quad-core trim.

AORUS
AORUS

Another rebadge. Yawn.

Gigabyte Aorus Radeon RX 570 4GB

When Vega? WHEN VEGA?!

IT'S BEEN ALMOST 14 months since Nvidia launched its GTX 1080 GPU, and in that time AMD has released diddly-squat to challenge it. Leaving the high-end marketplace to be monopolized by the gargantuan green giant, it seems that just as AMD has regained some ground in the processor market, thanks to its brilliant Ryzen processors, its GPU strategy has faceplanted into the ground in a liquor-fuelled stupor. These cards are, frankly, not that interesting. Not even as far as a rebadge is concerned.

Harsh? Absolutely not. Every new generational jump in GPU prowess has lead to one, maybe two, redesigned cards at the top end, with the older flagships then generally relegated down a step each time, usually with a slightly higher clock speed, and potentially some architectural tweaks to bring them in line with the new titans of graphical dexterity heading up the range. An R9 290 becomes an R9 380, a 280 becomes a 370, and so on.

With the 500 series, this just hasn't been the case. The 480 received a slight overclock and a boost to its TDP, pushing it from 150W to 180W, and that's it. And we can report that very little has changed with the 570, too. It still houses the same 2,048 shader cores, 128 texture units, and 32 ROPs; almost identical to last year's RX 470, bar a slight increase to its base/turbo clocks, and the TDP growing by a hefty 30W as well.

On top of that, there's still very little sign of Vega, outside of the rumor mill, allowing Nvidia to hold on to that massive market share, and bludgeon anyone interested in the upper echelon of gaming greatness with the inevitable team green tax.

Disappointing news indeed—there are whisperings that the newest RX 560 will have far more shader cores enabled than its predecessor, and therefore far greater performance than its esports-oriented, single-game cousin, but until we have confirmation from AMD on that, we're holding our breath.

Performance, then. Well, first off, can we just say that Gigabyte has done a fantastic job with the design of this card? Seeing Aorus make its way from gaming laptop brand to championing all of Gigabyte's latest and greatest hardware has been a breath of fresh air for the company. And this card is no exception. It has a crisp clean, dual-fan design, with only a single LED logo, a solid backplate, and plenty of cooling potential to keep even the longest gaming sessions well below the 70 C mark, with very little audible noise.

In game, the 570 is a fairly solid, mid-range 1080p card, hammering our test titles well into the high 50s—almost at that sweet spot. It still struggles with *Total War: Attila* and *Rise of the Tomb Raider*, but drop the antialiasing down a setting or two, and enable DX12, and AMD's superior support for the latest API happily brings this sub-$200 card up into the 60s.

So, who is this card for then? Well, there's not a lot of difference between this and the RX 470. That said, an upgrade is still an upgrade, and those looking to build a new system, coming from AMD's mid-range 200 series cards, or Nvidia's GTX 700 series, will be getting a solid deal with this offering. It's odd to say, but we feel as though AMD is somewhat short-changing us here. These cards don't offer anything particularly new, and do nothing you couldn't achieve on an RX 470 yourself with a touch extra voltage. The 4GB variant we tested here is just the right combo for the GPU housed within, and makes it an ideal card for 1080p gaming. – **ZAK STOREY**

VERDICT **7**

Gigabyte Aorus Radeon RX 570 4GB

+ **TRENDSETTER** Good mid-range GPU; solid 1080p performance; fantastic AIB design.

– **BEDWETTER** It's not Vega; terrible rebadge philosophy; still not as affordable as a 1060.

$190, www.gigabyte.com

BENCHMARKS

	Gigabyte Aorus RX 570 4GB	MSI Radeon RX 470 4GB	EVGA GeForce GTX 1060 3GB SC
Total War: Attila (fps)	**24**/31	21/28	**24/36**
Far Cry Primal (fps)	45/56	44/54	**49/61**
The Division (fps)	32/**56**	**36**/55	31/55
Rise of the Tomb Raider (fps)	7/33	**9**/31	**9/35**
3DMark Fire Strike (Index)	10,243	10,135	**10,251**
3DMark Time Spy DX12 (Index)	3,833	3,779	**3,905**

Best scores are in bold. Our test bed consists of an Intel Core i7-7700K, 16GB of Corsair DDR4 @ 2,400, an Asus Maximus IX Hero, and a 500GB Samsung 850 Evo SSD. All games are tested at their highest graphical profile, with AA turned up, at 1080p.

SPECIFICATIONS

GPU	Polaris
Lithography	14nm FinFET
Transistor Count	5.7 billion
Stream Processors	2,048
Texture Units	128
ROPS	32
Core Clock	1,168MHz
Boost Clock	1,244MHz
Memory Capacity & Type	4GB GDDR5
Memory Speed	7Gb/s
Memory Bus	256-bit
TDP	150W

A great, if limiting, design.

HP Z2 Mini G3

It tries to break workstation preconceptions, but ultimately reinforces them

WORKSTATIONS HAVE TO be big. Lesser systems can be smaller—even a gaming PC can be realized in a tiny space—but workstations have to be big. Don't they? Not long ago, Apple crammed an incredible amount of power into the Mac Pro, and that was tiny, and stylish, if somewhat flawed. So, maybe workstations don't have to be as big as we think. Take a look at this svelte little number: It isn't quite NUC scale, but at 8.5 inches square, it's far smaller than a standard workstation, especially when you consider that it packs an Intel Xeon and a Quadro graphics card in its tiny form.

Before we get carried away with the rest of the specs, it's worth noting that the Xeon in question isn't the sort of thing that gets your average server admin excited. The Xeon E3-1245 v5 at the heart of this machine runs at a fair lick—3.5GHz, turboing up to 3.9GHz—but only has four cores and 8MB of cache. It does offer up support for ECC memory, which HP has employed in the form of 2x 8GB DDR4-2400, but it only offers two memory channels.

The problem is that the lower order of Xeon processors doesn't look so enticing, given today's post-Ryzen world. Here's a four-core, eight-thread chip that struggles against some of Intel's own mainstream offerings, and gets annihilated when compared to the Ryzen 7 1800X. The defense, in this case, is that the chip has a TDP of just 80W, but you could drill down AMD's stack and grab a Ryzen 7 1700, which has a TDP of 65W, and it would still give this Xeon a good hiding.

Of course, the CPU is just one aspect of a workstation, and any system aimed at designers also needs to deliver on the graphics front. The Nvidia Quadro M620 would appear to offer up the goods, but like the Xeon, it isn't quite the big hitter you may first think. As that M-prefix suggests, this is ostensibly a mobile solution, which works in the tight thermal confines of HP's chassis, but lacks punch. The 30W TDP is impressive, and as a Quadro GPU, it comes with the driver certification for the top 20 packages (including AutoCAD), but it offers up only 512 CUDA cores, and boasts a mere 128-bit interface to the paltry 2GB of dedicated GDDR5 the GPU can call its own.

While we have our reservations about the long-term viability of the CPU and GPU, we're much more upbeat about the storage. The 512GB M.2 drive puts in a great turn of speed—a feeling backed up by the impressive benchmark figures. There's room in the Z2 Mini G3 for an additional 2.5-inch drive as well, so you can arm it with a surprisingly large amount of storage.

When it comes to benchmarks, the HP Z2 Mini G3 puts in a reasonable performance, but not sparkling, and for the kind of cash it will set you back, we expected a lot more. Given that this is aimed at serious use, where time is money, scores this far behind our zero-point speak for themselves. Compare it to the machines we've seen for this month's workstation feature, and you'll understand the false economy here.

We do love the design of the Z2 Mini G3, but we can't see who would buy it, especially with the slightly lackluster configuration we have here. Like the oft-criticized Mac Pro, design should not dominate, and here we'd recommend going for something bigger. It appears that workstations do indeed still have to be big. **–ALAN DEXTER**

BENCHMARKS

	ZERO-POINT	
Cinebench R15 (Index)	987	795 (-19%)
X265 Benchmark (fps)	20.69	16.92 (-18%)
Tech ARP x264 (fps)	21.93	17.56 (-20%)
CrystalDiskMark 4K Read (MB/s)	54.85	50.94 (-7%)
CrystalDiskMark 4K Write (MB/s)	171	165.5 (-3%)
PCMark 8 Creative (Index)	7,675	3,855 (-50%)
FryRender (Seconds)	225	263 (-17%)
3DMark Fire Strike (Index)	15,026	3,059 (-80%)
Rise of the Tomb Raider (fps)	41	9 (-78%)
Autopano Giga (Seconds)	614	745 (-21%)

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Our zero-point uses a Core i7-6700K overclocked to 4.6GHz, an XFX Radeon R9 Fury X, 32GB of Kingston HyperX Savage DDR4-2400, and a 256GB Samsung 950 Pro, mounted on an Asus Z170i Pro Gaming motherboard.

VERDICT

6

HP Z2 Mini G3

+ MARVELOUS Elegant design; quiet and cool in use; good software support; responsive drive.

− MALADROIT Underpowered; limited upgrade options; ultimately expensive

$1,799, www.hp.com

SPECIFICATIONS

Processor	3.5GHz (3.9GHz Turbo) Intel Xeon E3-1245 v5
Graphics	Nvidia Quadro M620 (2GB)
RAM	16GB DDR4-2400 ECC
Chipset	Intel C236
Storage	512GB HP Z Turbo Drive PCIe SSD
Ports	4x USB 3.0, line-in, 2x USB 3.1 Gen 1 Type-C
Connectivity	Intel Gigabit RJ45
Weight	4.5lb
Size	8.5 x 8.5 x 2.3 inches
OS	Windows 10 Pro

ROG EDITION 10
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RAMPAGE V EDITION 10
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Excessive? Yeah, but it's incredible.

Asus ROG Rampage V Edition 10

The best Asus has to offer

IT'S NOT EVERY DAY we get something as exceptional as this. A board that challenges all logic, positioned so high on the economic spectrum only the rich kids of Instagram and those really looking to burn holes in their pockets can attest to its brilliance.

This is, without doubt, a ridiculous board. Not in the same way as Asus's X99-E-10G workstation motherboard, but in a ludicrous concept kinda deal. It's a well established fact that gaming benefits from higher performing single cores than slower performing multi cores, as found in the Broadwell-E and the X99 platform. That's not to say that this dollar-burning combo is particularly bad at gaming, merely that it's unnecessary. For the purist, there's no logical reason to spend all that extra cash on an eight-core processor and above.

But for the professional, the streamer, the YouTuber, the showcaser, well, that's a different story. Let's talk about what you get for all that cash, a plump $570. Well, outside of the 2011-3 socket and quad-channel memory, supporting up to 3,333MHz, you also get a neat 5.25-inch DAC capable of powering even the most ambitious 600 Ohm headphones, some stellar RGB lighting (genuinely, this stuff actually looks pretty solid), wireless A/C, two Gigabit Ethernets, two USB 3.1 Type C, two USB 3.1 Type A, four USB 3.0, two USB 2.0, and even a combi port, plus the usual assortment of 5.1 audio, TOSLink, and the two neat additions of BIOS reset and clear CMOS switches in the rear.

However, it's the board itself that touts the biggest arsenal of connectivity, with no fewer than four PCIe x16 slots, a plethora of fan headers, USB 2.0 headers, RGB headers, two USB 3.0 headers, and a full bank of 10 SATA 6Gb/s, followed by Intel's now almost defunct U.2 connection standard. Plus, it looks stunning. The rear I/O cover, in particular, immediately draws your eyes to it, especially with that slice of RGB lighting baked in.

Then there's the performance, which really pushes the boat out for the Rampage V Edition 10, particularly when it comes to overclocking. For the first time in a very long while, we managed to push our Core i7-6950X beyond the 4.3GHz limit—admittedly, only to 4.4GHz, with 1.45V in the V Core, but achieve that it did. We have seen the X99 Strix Gaming achieve similar, but it wasn't anywhere near as stable as our overclock on the Rampage V, and it took multiple attempts to get both the voltage and temperatures just right.

On top of that, power consumption is equally impressive. In our power load test, we saw a total power draw of 230W from the wall, in stark contrast to the X99 Micro 2's 350W. In fact, we were so impressed that we left it running for 10 minutes, and still saw very little fluctuation in figures.

Ultimately, this motherboard is not for the faint of heart. Its extreme price puts it out of reach of all but the most enthusiastic enthusiasts. It's ideal for liquid cooling, and those looking to build a super-clean system using the X99 platform. Combine this with one of EKWB's full cover monoblocks, and it's truly a thing of beauty. But does it warrant the price? Only if you have access to a plethora of processors you can bin for it. For the average punter, that's simply not the reality, and you would be far better off investing in something lower down in ROG's lineup, such as the Strix X99, or even the Prime instead. **–ZAK STOREY**

BENCHMARKS

	Asus ROG Rampage V Edition 10	EVGA X99 Micro 2
X265 (fps)	**27.33**	26.81
Cinebench R15 Multi (Index)	**1,795**	1,765
Fry Render (Seconds)	**111**	112
AIDA64 Memory Latency (Nanoseconds)	74.5	**74.4**
Power Draw Idle/Load (W)	81/**230**	**63**/349
Crystal Disk Sequential Read (MB/s)	**548**	545
Crystal Disk Sequential Write (MB/s)	**525**	523
Far Cry Primal (Avg fps)	**42**	**42**
3DMark: Fire Strike Extreme (Index)	**9,644**	9,603
Maximum OC Achieved (GHz)	**4.4**	4.3

Best scores are in bold. Our test bed consists of an Intel Core i7-6950X, 32GB (4x 8GB) of Corsair Dominator Platinum DDR4 2400, an Nvidia GeForce GTX 1080, and a 500GB Samsung 850 Evo SSD. *Far Cry Primal* tested at Ultra at 4K.

VERDICT
8

Asus ROG Rampage V Edition 10

⊞ **RAMPANT RA...** Stunning OC performance; clean BIOS; included DAC; awesome design.

⊟ **JUST RIDICULOUS** Price; niche audience; large form factor.

$570, www.asus.com

SPECIFICATIONS

Chipset/Socket	X99/LGA 2011-3
Form Factor	E-ATX
Memory Support	128GB DDR4 @ 3,333MT/s
M.2/U.2 Support	1x M.2 PCIe x4, 1x U.2
SATA Support	10x SATA 6Gb/s
Max PCIe Support	4x PCIe 3.0 x16 (x16x8x8x8)
Rear I/O	1x PS/2 combi, 2x Gigabit Ethernet, 2x USB 3.1 Type C, 2x USB 3.1 Type A, 4x USB 3.0, 2x USB 2.0, Optical S/PDIF out, 5.1 audio, clear CMOS button, wireless A/C

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techradar.com

Intel Optane M.2 32GB PCIe 3.0 x2 NVMe Cache

Reinventing SSD caching, but only for Kaby Lake

IN APRIL, Intel launched its first SSD with 3D XPoint Technology, the Optane SSD DC P4800X. Boasting incredible performance at low queue depths with high endurance, it's targeted at enterprise users—$1,520 for a 375GB model. The PCIe interface is likely a bottleneck to the P4800X's performance, and Intel has a different plan for the consumer market: Optane Memory. The M.2 form factor drives offer a new alternative to Intel's aging Smart Response Technology (SRT) and its 20/24GB SLC SSD caching drives from 2011/2012.

Capacity is limited to 16GB or 32GB—priced at $44 and $77. You could RAID several drives to get more capacity, but even four would only deliver 128GB—not to mention being priced about the same as high performance NVMe drives, such as Samsung's 512GB 960 Pro. Clearly, Intel's intent is for budget and mainstream users with plain old hard drives to upgrade to "near-SSD" levels of performance.

Setup is simple: open your PC, install the Optane Memory module, and power up. Then install the necessary Intel Optane Memory app, and enable Optane Memory support. This takes a few minutes and modifies your PC to boot from the Optane module, along with copying some Windows files. Optane only provides an SSD cache for the C: drive, and if you want to remove the Optane module, you must use the same app to disable Optane support.

The problem with SSD caching is that it requires having the data you're accessing in the cache before it helps, so the first time you use an app, it feels like you're going to a hard drive—because you are. But as the system learns your usage patterns, critical and commonly used files end up in the cache, and improve responsiveness. Intel's SRT was underwhelming, but the faster M.2 x4 PCIe connection and extremely low latency 3D XPoint help.

In a few instances, the 32GB module is several times faster than a pure hard drive solution. Particularly noteworthy are the Adobe Premiere, Windows, and *Doom* launch times. Optane Memory is also intelligent about what files it caches, so movies don't need to consume precious space. There's only so much a finite cache can do, of course, so if you regularly access apps that exceed its capacity, performance falls back to HDD levels. We found actively switching between four games was enough to exceed capacity—bad for benchmarks, but not an issue for many people.

Beating a hard drive isn't difficult, so we grabbed a budget 480GB SATA SSD for comparison. It costs about the same as a 2TB HDD plus the 32GB Optane module. The performance ties the Optane solution on the tests we ran. More importantly, performance is always high, as there's no cache to populate. Optane can also help performance if combined with a SATA SSD.

The biggest concern is that Optane Memory is limited to a very narrow use case. It requires an Intel 200-series chipset motherboard that supports the feature, and a Core i3 or better Kaby Lake CPU. So the only people who can use it are running Intel's latest and greatest CPUs and mobos, but they'll mostly benefit if they're running hard drives, not SSDs, which we recommend against—your boot drive should be an SSD. **–JARRED WALTON**

BENCHMARKS

	HDD + Optane	SSD + Optane	512GB SATA SSD	2TB HDD
Boot	15.9	**15.8**	18.3	27.6
Boot to Idle HDD	33.2	**32.9**	37.3	83.2
Shutdown	8.3	**6.3**	6.4	12.5
Google Chrome	3.1	**3.0**	3.6	6.6
Adobe Premiere Pro	7.9	**7.7**	8.5	33.4
Steam	19.8	**18.5**	20.8	26.3
Doom	31.0	**29.8**	35.2	79.6
Doom Level	10.4	**10.2**	11.0	11.3
Playerunknown's Battlegrounds	30.7	**26.5**	31.7	44.3
Playerunknown's Battlegrounds Level	14.9	**14.2**	14.4	30.6

All times in seconds. Best scores are in bold. Our test bed consists of a Core i5-7500, 2TB WD Black HDD, 512GB Crucial MX100, 32GB Optane M.2 Cache, and 16GB of DDR4-2400 on an Asus Prime B250-plus mobo.

VERDICT

6

Intel Optane M.2 32GB PCIe 3.0 x2 NVMe Cache

+ **LOTS OF CASH** Beats a hard drive; low latency; easy to use.

− **LIMITED CACHE** Low capacity; not much cheaper than a budget SSD.

$77, www.intel.com

SPECIFICATIONS

Capacity	32GB
Interface	PCIe 3.0 x2
Controller Protocol	NVMe
NAND Type	3D XPoint
Sequential Read	1,200Mb/s
Sequential Write	280Mb/s
Read IOPS	300K
Write IOPS	70K
Warranty	Five years

AOC AGON AG251FZ

So fast, it really hertz

SPEED MATTERS. How do you like that for a sales pitch? If there's any truth to it, you'd think AOC's AGON AG251FZ gaming monitor is a certainty for success. After all, it clocks in with 240Hz refresh rate capability.

It wasn't too long ago that LCD monitors capable of anything north of 60Hz were unusual. Now, 120Hz and even 144Hz screens look like technological chumps. But, as refresh rates creep ever higher, a conundrum slides into smoothly-rendered view. Is there a point at which increasing the refresh rate stops making a difference? What are the limits of human vision here?

Hold that thought while we navigate the AG251FZ's main feature set. It's a 24.5-inch LCD monitor with a Full-HD 1080p native resolution—that's 1920x1080 pixels. In this age of the 4K, 40-inch TV for under $400, the AG251FZ looks painfully pricey.

That value only looks worse when you consider that it also uses low-cost TN panel technology, not the more expensive IPS or VA alternatives. But there is logic to all this: To drive the latest games at full detail, fast enough to make full use of that 240Hz refresh capability, is no small feat, even at 1080p. Up the ante to 4K or even 1440p, and the chances of achieving anything close to 240fps are outstandingly remote, even with the most powerful graphics hardware.

Similarly, given the remit is fast-paced gaming, using the fastest screen tech, even if it has shortcomings in other areas, makes sense. Add to that a number of other gaming-friendly frills, including a low-input lag mode and FreeSync support, and the result is an overall package that looks promising, even at that $500-plus price.

But how good is it in practice? For starters, the TN panel is one of the better examples of the twisted nematic art we've seen. In fact, for colors and contrast, it's as good as we've seen from this panel type, other than the recent crop of 4K TN models, which are really in a class of their own.

It's still not really a patch on the best IPS and VA screens, of course. That's especially true if you factor in the latest models with quantum dot or HDR technology. Most obvious are the relatively narrow viewing angles. It's the one metric by which TN technology has conspicuously failed to close the gap on other LCD panels. But in isolation, the AG251FZ puts on a decidedly decent show for basic image quality.

So what of that crazy-high refresh rate? We're in the realm of subjectivity, but for what it's worth, in various synthetic tests, including text scrolling and image panning, it is just possible to discern the difference between, say, 120Hz and 240Hz. It's not nearly as obvious and dramatic as the step up from 60Hz to 120Hz, but it's there.

Picking that difference out in games is a whole different story, however, and it's not something we could do reliably. Now, that's not to say there are no benefits, but they are relatively subtle. Of course, that's assuming you can even drive said game beyond 120Hz.

That said, the AG251FZ's other gaming features certainly add to the package. The pixel response is about as good as it gets, and the overall experience is utterly lag-free, even without enabling low-lag mode. If you're looking for a seriously quick and slick panel for first-person shooters, the AG251FZ should certainly be on your list.

For everyone else, it's something of a niche proposition. Even for gamers, the benefits of 240Hz are probably marginal versus a 120Hz monitor. In reality, most will prefer more pixels or a higher quality panel for similar money. **–JEREMY LAIRD**

VERDICT

7

AOC AGON AG251FZ

+ HERTZ SO GOOD Crazy high refresh rate; seriously fast pixel response; decent image quality.

− MEGAHURTS IPS and VA panels look prettier; diminishing returns above 120Hz; darn expensive.

$550, http://us.aoc.com

SPECIFICATIONS

Panel Size	24.5-inch
Native Resolution	1920x1080
Pixel Density	89.91ppi
Panel Type	TN
Maximum Refresh	240Hz
Response	1ms
Contrast	1000:1
Display Inputs	DisplayPort, DVI, HDMI with MHL, VGA
Connectivity	USB 3.0 x4
VESA Mount	100 x 100mm
Warranty	Three years

AG251FZ
AGON

Alt fact: Humans can only see at 30Hz.

Logitech G413 Carbon

A quality custom keyswitch keyboard contender

THERE'S A FIGHT GOING ON in the lower divisions of the mechanical keyboard market. Logitech, having spent a good amount of time punching sides of design beef and lifting crunchy keyswitch logs above its head, is ready to wade right into it. But does it have what it takes to knock out the muscular champions of the enthusiast market with this clean keyboard, or should it be fighting more dirty?

Let's put that design on the canvas first of all. The keyboard base, more dense and weighty, at nearly 2.5lb, than it has any right to be, is topped with a generous slab of brushed 5052 aluminum alloy, a toughened corrosion-resistant mix. The metal is given a carbon-colored coating in the red-lit version tested here, and left silver—and accompanied by white LEDs—in the alternate variant. It's hard to argue that it doesn't look damn sexy, particularly given the G413's bezel-free floating keys, although the fact that it's coated aluminum means it's easily scratched, so don't expect those looks to last forever.

The business part of any mechanical keyboard is, naturally, the actual mechanics, and under the caps here we're treated to Logitech's proprietary Romer-G switches. The company makes some extravagant claims about its tech—up to 40% more durable than the leading competitor, for example—but it's reasonable to expect that you'll rub through the keycap coating and the skin on your fingertips before you manage to hit 70 million keypresses. What counts is how the switches work, and they're absolutely fine. They're silent in themselves, consisting of a sprung, hollowed-out upper, with a reasonably stiff (but not tiring) 1.6oz resistance, and there's certainly a heartwarming amount of plastic on aluminum clatter (and a faint spring-ringing noise, which grates on the skull like chewing foil) when you truly get going. Travel is deep and satisfying, although light-fingered typists will revel in the minuscule sixteenth-of-an-inch actuation distance, which means even the lightest jab gets the job done.

Those keys, lit by one red LED each, are slightly darker than their metalized plinth, for a subtle contrast, and bleed only the faintest glow beneath. The LED position, deep within the keyswitch itself, as opposed to the offset positioning necessitated by, for example, the central post design of Cherry MX switches, means keys are labeled in the middle, and fairly consistently lit. Disappointingly, or perhaps understandably, given the G413's price point, there's no way to selectively light individual keys, although Logitech is generous enough to include a key puller and a selection of beveled gaming keycaps, if that's your thing. You'd best enjoy them, because the obscurity of these switches means you're unlikely to find third-party replacements in the wild.

Enough of the brawn—what about the brain? There's a game mode included to prevent accidental Windows key presses, media functions are tucked away via an Fn/F-key combo, and there's variable brightness on the hardware itself. Teaming it up with the Logitech Gaming Software suite lets you set the LEDs breathing, flip the Fn activation, extend the blocked keys in game mode, and customize what Logitech calls the "G keys"—they're the F-keys, guys, come on now—with whatever macros or keypresses you'd like. Profiles are included for a bunch of popular games, and it detects what you have installed to make it easier. It's a shame customization couldn't be taken further, though, because we're not in the habit of reaching that far up the keyboard in clutch situations.

For $90, this is fit, and it's ready. But it's in such a quality mix—Corsair's excellent $80 K63, HyperX's $100 Alloy FPS, both of which offer slightly higher specs—that it's going to have to scrap hard for your attention. The keyswitches are different enough from the ubiquitous Cherry MX range that it could well be worth a try, but be aware of its issues first. **–ALEX COX**

VERDICT 7

Logitech G413 Carbon

+ CARBON Pleasing switches; heavyweight construction; beautiful looks.

− COME ON Ringing springs; limited customization options.

$90, www.logitech.com

SPECIFICATIONS

Switch Type	Logitech Romer-G
Form Factor	Full size
Media Keys	Yes
Macro Keys	Customizable
LEDs	Red
Key rollover	26 keys
Pass-Through	USB 2.0
Dimensions	5.2 x 17.4 x 1.3 inches
Warranty	Two years

Corsair Glaive RGB Aluminum

A wolf in a mouse's clothing

JUDGING A BOOK by its cover is, as your parents erroneously told you when that less-than-attractive classmate asked you to prom, a terrible mistake. This is conclusively proven by Corsair's Glaive, which couldn't seem more vanilla when sitting in the box, yet—unlike your awkward, nose-picking dance partner—actually turns out to be damn good company, once it's out in the world.

The Glaive is, as is the law these days, full of RGB LEDs. It forgoes the desktop halo of the likes of the Razer Deathadder Chroma and Asus Gladius II, in favor of a three-zone configuration, which lights the logo, bands on either side of the palm edge, and a pair of front-mounted headlights. Each zone can be intricately, intimately configured, with gradient fades, rainbow effects, flashing colors, or anything you like, though you can't make any zone display more than one color at once. The LEDs aren't the brightest, but that suits; they're placed in understated locations, and aren't necessarily there to shout, more to whisper your love of colored peripherals.

The only other lights on the Glaive come in the form of the DPI markers, which show which of the five DPI levels you've selected. Unusually, these aren't hard-coded into the unit, and can be individually configured, like the LEDs, in the Corsair Utility Engine 2 software, which we should take a second to praise: It's absolutely wonderful. Every manufacturer has a peripheral configuration app these days, and we've not seen one as easy to understand, or as deeply detailed, as Corsair's. Good job.

You can also use CUE 2 to configure each of the Glaive's six buttons—even the wheel-hugging DPI switcher—to any function or macro you desire, and there is a further DPI slider for a sniper resolution, which (mercifully) isn't set by default, instead being offered as an option. Switching between layouts is absolutely trivial, so you can glide from a desktop mode to a gaming one in a couple of clicks. The sensor, a custom-built 16,000 dpi number, can be software calibrated, and worked perfectly on each of our test surfaces—it ranges from butter-smooth to outrageously sensitive, depending on your preference.

As a piece of hardware, Corsair has clearly put a lot of thought into the Glaive's construction. It's beautifully weighted, and while it lacks those gimmicky weights that you can take in and out of certain other mice, we suspect that's because Corsair's braniacs got it right, and knew you would be happy with it as it is. The palm surface is covered in a soft, almost velvety plastic coating—the kind that does degrade over time, so be wary—while the edges and notched wheel are clad in a textured rubber, which grips to your hand if you so much as look at it.

What's more, there's a gimmick on offer here, and one that works: The panel on the left edge can be quickly replaced. Pull it off, select one of the alternatives, and it mounts itself back on via a combination of built-in neodymium magnets and a subtle alignment groove, giving you the option of a smooth, close-mounted panel, a textured and slightly wider panel, or a thumb-nestling extended curve. While you're unlikely to need to change them in a hurry, the use of magnets rather than clips is a clever idea, because there's nothing to really break.

It's difficult to use anything other than superlatives to describe the Glaive. Perhaps, if you have very small hands, it might not suit your particular tastes. Maybe you like your lights more brash and eye-burning, or you're already tied into another RGB ecosystem. You could be offended at spending $70 on a mouse. But on a comfortable, versatile mouse that will do everything, from desktop to gaming, exactly as you want it to? Well, that's up to you. **–ALEX COX**

VERDICT
9
KICK ASS

Corsair Glaive RGB

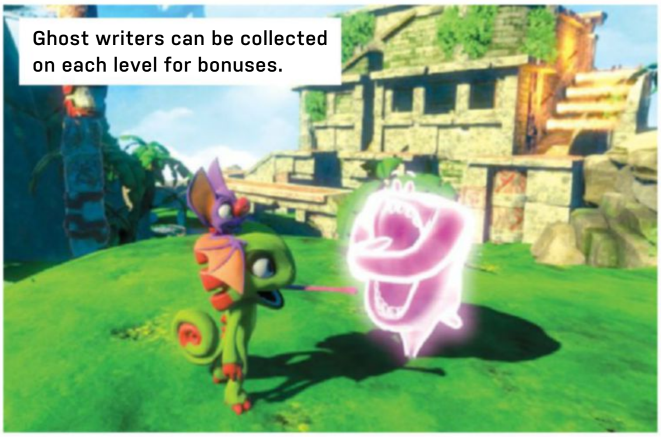
⊞ **RAVE** Well weighted; hugely configurable; great software.

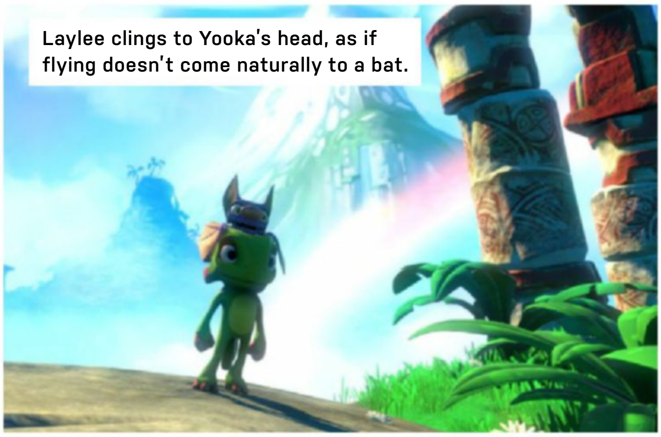
⊟ **KNAVE** Dim LEDs; single color zones only.

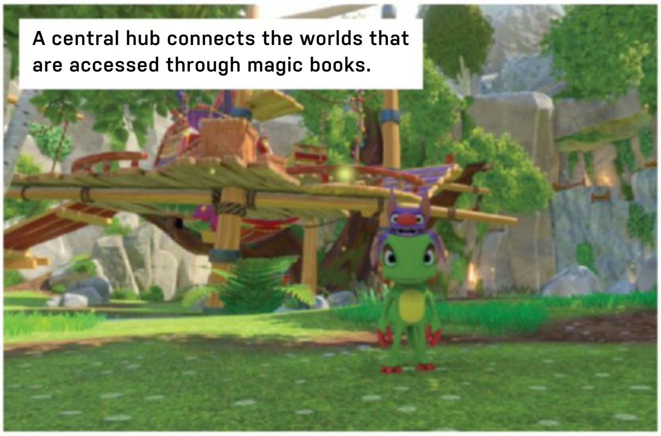
$70, www.corsair.com

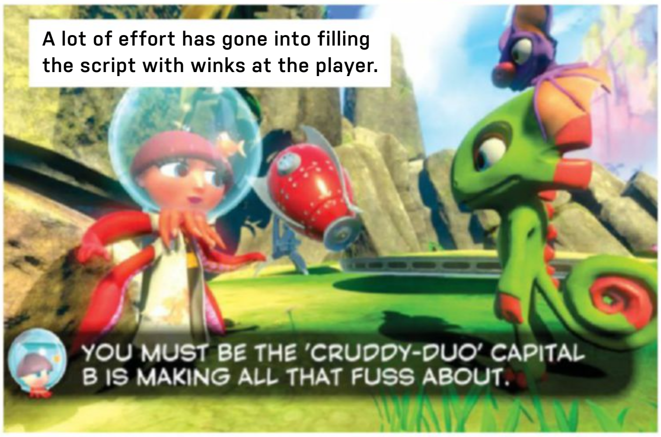
SPECIFICATIONS

Sensor	Optical
Sensitivity	16,000 dpi
Sensor Model	Custom PixArt PMW3367
Polling Rate	1,000Hz
Programmable Buttons	6
LEDs	3 zones
Cable Length	5.9 feet
Weight	4.3oz


Ghost writers can be collected on each level for bonuses.


Laylee clings to Yooka's head, as if flying doesn't come naturally to a bat.


A central hub connects the worlds that are accessed through magic books.


A lot of effort has gone into filling the script with winks at the player.

YOU MUST BE THE 'CRUDDY-DUO' CAPITAL B IS MAKING ALL THAT FUSS ABOUT.

Yooka-Laylee

Lizards and bats, together at last

NINTENDO 64 OWNERS who played more than *Mario Kart* and *WWF No Mercy* may recall *Banjo-Kazooie,* in which a bear and a bird took on a witch. It sold nearly two million copies in the States, and spawned a couple sequels. *Yooka-Laylee* is *Banjo's* spiritual successor, Kickstarted and made by a bunch of the same people.

So, instead of a bird and a bear we get a lizard and a bat, and instead of a witch there's an anthropomorphic personification of the Marxist view of capital. Capital B (for Bourgeoisie? No, he's a bee) isn't wearing a top hat, but his shiny shoes, pin-striped suit, and bandit mask mark him out as the kind of corporate raider who'd take your grandmother's savings in seconds. Aided by the nefarious Dr Quack, his latest raid has been on books, and it's up to Yooka and Laylee to get them back by collecting quill pens and pages (the main goal), and blah blah blah, it's all just a veneer to get you to jump, roll, and smash your way through various worlds. And an excuse for bad puns.

Which brings us to the dialog. In true *Banjo* style, voices are stylized as a series of grunts, while conversations play out in subtitles. This may be charming, but you waste time on dialog screens, even when clicking to make them go faster. It doesn't help that clicking a character you've already spoken to replays the whole conversation. The script is knowing, self-referential, and comes close to the fourth wall on occasion—a pixelated dinosaur being asked if he's in the right game, for example.

Graphically, it's sumptuous. Unlike the pursuit of the photoreal, cartoonrealism is a quest that repays explorers many times over, without falling into any uncanny valleys. But the worlds don't hang together well. Anyone who heads off the path at the start of world one discovers a skeleton in a cooking pot. Fight off some easy enemies for him, and he tells you to come back later, when you've "expanded the world." What? You don't discover what this means until you've exited the level, and returned to the hub. Characters dotted around say they have no business with you, with no clue as to how you get their attention. Races seem unwinnable, but just require mastery of the game mechanics. A puzzle that lets you pass when the fire goes out has an impassable bit halfway up, leaving you wondering whether it's a bug rather than an ability gate. Things could be clearer. And the camera could be better, too—the one thing most complained about in 3D platformers, it's capable of guiding you off the edge of the level or refusing to let you look up to see what's casting a shadow.

There's a lot going on in *Yooka-Laylee.* If it grabs you, there are five worlds' worth of imaginative platforming (and a slippy-slidey ice world). For today's gamers, however, it may be unfamiliar, and while it's a shame that many may bounce off the game without discovering its enormous heart, it wouldn't be entirely unexpected. **–IAN EVENDEN**

VERDICT 7

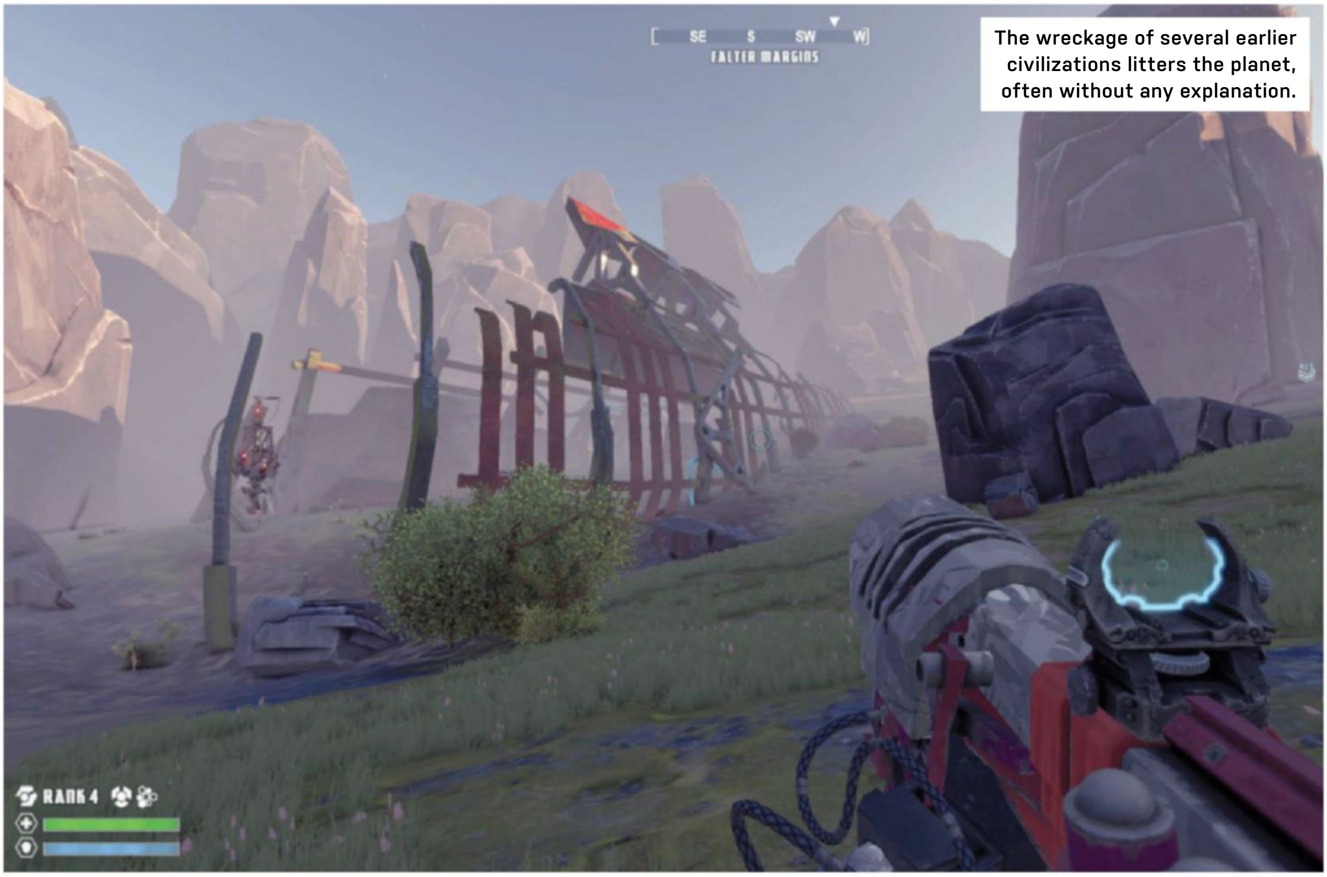
Yooka-Laylee

+ BAT Beautiful graphics; great music; plenty of content.

− BEE Strange mix of retro and modern; annoying camera; poor signposting.

RECOMMENDED SPECS Intel i5-2500; 8GB RAM; Nvidia GTS450 or Radeon 6850HD.

$40, www.playtonicgames.com, ESRB: E 10+



The wreckage of several earlier civilizations litters the planet, often without any explanation.

The Signal From Tölva

In space, no one can hear you scratch your head

THE PLANET TÖLVA has certainly seen some action. In addition to the recently wrecked frigate whose parts are scattered across its surface, there's plenty of evidence of previous conflicts. Military bunkers are almost everywhere, and the remains of giant robots lie draped across the landscape.

Smaller robots swarm over it, too, and that's where you come in. Drawn to the planet by a signal, you are patched into a Surveyor robot by a similarly cybernetic information broker, then left with a list of things to scan. Complicating matters are two other robotic factions: the Bandits and the Zealots. They exist mainly to harass you as you cross the eerie landscape, all broken rocks, angel-like insects, flying mantas, and areas gated by radiation, chemicals, or worse, which you need to level up to enter.

Increasing your rank, scanning objects, collecting resources, and blowing other bots into piles of bolts unlocks weapons and chassis modules for your robot. Not that you're stuck with the same one: In a perfect amalgamation of the gaming tropes of infinite lives and fast travel, *Tölva* allows you to exit your bot, hacking into a new one at spawn points across the map, with body modules and weapon loadouts unchanged.

Giving up a weapon slot for a "phreaker" enables you to hijack allied robots and eventually head out as a pack of five, enough to take on the marauding gangs of enemy bots that stand between you and your scanning sites, or who occupy spawn points you want to capture. Your metal body feels heavy, feet slamming into the ground, and weapons kicking in a way that makes it clear you're something large and metallic, blasting away with tremendous energy.

And it's good stuff, this robot-blasting, but there's very little driving you forward apart from the need to scan more objects. The narrative, which promises much with its mysterious setup, runs out of steam, and by the time you're seeing either of the two endings, you may be left feeling as if you've missed something, some exposition speech or cutscene, that would fill in the gaps.

What you do get is a wonderful PDF in place of a manual, full of history and lore about a setting so rich it surely promises more games will be made within it. This, along with the mysterious nature of the game, feels like a tiny window into a larger universe, your presence just a cog in a bigger machine, in the same way your robot is laboring away to get a glimpse of something infinitely larger. The mystery is compounded by fragments of text that appear to point the way to the deeper mystery of the planet, and ghosts in the landscape that seem to be watching you.

Tölva is a shortish, deliberately paced game made by five people, its almost cel-shaded graphics unlikely to trouble any recent GPUs, but it punches far above its weight in terms of mystery and atmosphere, even if it does take the mystery element slightly too far. **–IAN EVENDEN**

VERDICT 7

The Signal from Tölva

➕ **WALKING** Mysterious; good range of guns; fantastic setting.

➖ **STALKING** Perhaps too mysterious; lots of walking; needs more answers.

RECOMMENDED SPECS Intel i7-4790 3.6GHz; 16GB RAM; Nvidia GTX 970.

$20, www.thesignalfrom.com, ESRB: Not rated

LAB NOTES

BO MOORE, TECHNOLOGY EDITOR

Laptops Galore

Observations on a new generation of portable gaming

I'VE HAD A LITERAL STACK of laptops on my desk lately. I'm working on a large update to our online best gaming laptop buying guide, and that means calling in just about every portable gaming machine under the sun. But as the books piled up, and the benchmarks started running together, one thing in particular stood out: I'm incredibly impressed at how slim and trim gaming laptops have become.

Time was that for a laptop to have any sort of respectable pixel-pushing power, it meant that it also required a chassis that looked more like a Harrier jet exhaust than a notebook. These powerhouses pushed the envelope in terms of what could be called portable, and "laptop" was almost certainly a misnomer—I don't know anyone who would actually sit one of those behemoths on their lap. However, things have changed. Perhaps it's advances in cooling technology, perhaps it's the lower TDP of Nvidia's Pascal GPUs, but this generation of gaming laptops is thinner and lighter than ever before. Sure, most of them still aren't exactly what you would actually classify as "thin and light"—that honor is still reserved for the lightweight notebook form factor. But a few millimeters more, and you have machines sporting GTX 1060s (sometimes even more powerful) that are more than capable of locking down 1080p @ 60fps or higher.

Even more, many of these machines have features previously reserved for the luxury of the desktop: displays with 120Hz refresh rates and G-Sync technology, or keyboards with mechanical switches and RGB lighting. And perhaps more impressive than anything, they don't require some sort of Faustian bargain to purchase. OK, maybe if you want all those features in one, but there are many more than capable machines out now that don't cost an arm and a leg—and most of them don't even burn my lap.

Not quite thin and light, but not far off.

JARRED WALTON

Senior Editor

You want more threads? AMD has heard your pleas, and will be launching Ryzen Threadripper this summer. Based on its Epyc, aka Naples, server parts, Threadripper will launch with up to 16 cores and 32 threads. No details on pricing yet, but probably (a lot) more than $1,000. Intel's answer is Skylake-X, which will hoist the Core i9 flag. Core i9 will have up to 12 cores and 24 threads on the top model. It will also feature a 1MB L2 cache per core—four times the amount of the mainstream consumer parts. Both CPU lines will run on new platforms: X390/X399 chipsets and socket SP3r3 for AMD, and X299/LGA2066 for Intel. I can't wait to see these chips demolish our benchmark suite!

ALAN DEXTER

Executive Editor

Workstations, it transpires, aren't easy to benchmark. We're used to battling with desktop apps and games here, but finding quality workstation-level benchmarks proved tricky. The big problem is consistency. For instance, Kolor Autopano Giga 4.4.1 was frustrating—it crashed several times, exacerbated by the number of images we had to work with, which saw whole days lost to benchmarking this one app. It did seem more consistent on Intel systems, although that's a relative term, as we saw render times vary wildly, and it was only when checking the final image in Photoshop that we could be sure that it had completed properly. We got there in the end, but it wasn't easy.

Editors' Picks: Digital Discoveries

Zak Storey, reviews editor, and Tuan Nguyen, editor-in-chief, indulge in their passions

SPOTIFY

I recently had the pleasure of introducing old papa Storey to the wonders of Spotify. After him clamoring about "where exactly I import my music from nowadays," I pointed him in the direction of my favorite streaming service. You may remember a while back, I was a big advocate of Tidal. Its FLAC quality audio was impressive. However, over time, two things put me off. First, a lack of Metallica, and second, the $20 a month for the HRA good stuff. I swapped to Spotify on a trial account to give it a shot, and haven't looked back since. It's a great service.

I pay $15 a month for the Family bundle, allowing myself and four others (people living at the same address) access to Spotify's premium features, including high quality 320kb/s streams, offline downloads, and no adverts. I have a fairly hefty data plan on my Samsung Galaxy S7 Edge (4GB a month), so I stream all of my music directly, with nothing stored locally, saving storage, and the same goes for my desktops, both at work and at home. On top of that, I follow the artists I like, save the albums I love, and create and follow playlists I enjoy, all of it backed up in the cloud, ready to listen to on any device, anywhere in the world.

$15 Family, www.spotify.com

DELL UP3218K

What is actually driving the evolution of PC technology? High-res displays. Yup. When you think about it, 4K and now 8K displays are what's pushing the boundaries of PC performance. To some extent, VR is helping out as well, but VR is really about the display, too.

I've been fortunate enough to bring in Dell's new and insane 8K UP3218K, which is a big 32-inch panel sporting a jaw-dropping 33 megapixels of screen real estate. At one point, viewing images off my Canon DSLR camera didn't fit on my screen, but the Dell UP3218K will pretty much gobble up most digital files without having to zoom out. In fact, you can fit four 4K images comfortably on the UP3218K in their native size.

This screen is the sharpest, most lifelike, most vivid display I have ever used in my entire life. Everything looks hyper-realistic—as though you're looking through an actual window, to whatever it is that's on the other side. The caveat, however, is finding 8K content. It's practically non-existent right now. With 4K-scaling turned on, though, the UP3218K is face-melting, in the best way possible. I have never looked at a better screen. If it came down to OLED or 8K for my PC? I'd go with an 8K display.

$5,000, www.dell.com

GEEK TESTED & APPROVED

Xiaomi Mi Band 2

THE HYSTERIA surrounding smartwatches has finally calmed to the point where we can start looking at them objectively. The potential for something like the Apple Watch is undeniable, but it seems realizing that potential is tougher than expected. Throw in the considerable $269 price, and it's easy to see why such devices haven't quite taken off.

We haven't written off the genre, though, as the inclusion of the Xiaomi Mi Band 2 proves. Here's a cheap and cheerful device that does so much well, that we can forgive it some of its shortcomings. True, it isn't anywhere as versatile as some of the more expensive offerings, but what it does, it does well. Predominantly a step-counter and heart rate monitor, this is a smartwatch (it tells the time, too) that is light and comfortable, and IP67 splash resistant. It'll also monitor your sleep patterns, although results vary. You can set it to alert you to messages, calls, or idleness, as well as specific app alerts, although its main use is as a step-counter.

The Mi Band 2's pedometer algorithm does a good job of filtering out erratic movements and false starts, and has improved with the latest firmware updates. The Android app, Mi Fit, shows your activity in a clear and concise way, and synching is easy—although leaving Bluetooth on drained our smartphone's battery. One of the most impressive aspects of the Mi Band 2, though, is the battery life—it lasts a month between charging. Seriously, a month. **–AD**

$36, www.mi.com

LETTERS

WE TACKLE TOUGH READER QUESTIONS ON...

> Liquid Longevity
> Maglev Bonus
> Bottleneck Tips

Liquid Lifespan

I am going to build an AM4 PC. I planned to use a closed loop pre-filled liquid cooling system, and was very interested in the Silent PC article in the April 2017 issue. Why did you use a liquid cooling system with a visible reservoir, that you had to fill? Am I making a mistake or overlooking something? I keep systems for five years or more. Is there an expected lifespan on liquid cooling tubing?

–Charlie B

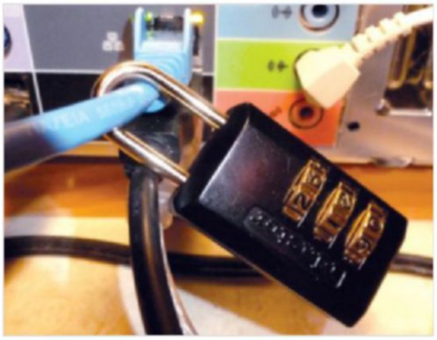
REVIEWS EDITOR ZAK STOREY RESPONDS: In regard to why we used an open loop, it comes down to surface area. For the everyday user, a closed loop AIO is perfect. It's easy to install, comes with a hefty warranty, is low maintenance, and packs substantial cooling potential. However, you're limited by surface area. All cooling—whether you're using an air tower for your CPU, a blower-style graphics card, an AIO liquid cooler, or even a passive cooling solution—works off total surface area. In short, cooling operates via the transfer of heat from one place to another. For a PC, that's moving heat from a processor to an array of fins to expel that heat into the surrounding air. With an air cooler, heat pipes transfer water vapor from the hot processor by convection to the fins, where it's cooled, forms a liquid, and goes back round and down to the processor to start the process again, drawing heat away from your CPU.

Liquid cooling operates on much the same principle, except the volumes are increased. Instead of water vapor and convection, a pump moves fluid past the processor, drawing heat out of the CPU and waterblock, to the radiators, where it's cooled by fans, then sent back to the CPU to repeat the process. The more radiators, and the bigger they are, the more heat you can expel out of them, and the less heat you have in your processor and coolant.

For AIOs, you're usually limited to 240 or 280mm radiators, 30mm thick, and capable of supporting two to four fans. However, with an open loop system, you can decide how big the radiators are, how thick you want them, and how many. Which is great for reducing processor temperatures, or in a loop where you have multiple GPUs. For instance, our water-cooled overclocking build from the July 2016 issue, at 4.8GHz, under load, would reach 82 C under a 280mm AIO; in

[NOW ONLINE]

HOW TO MAXIMIZE INTERNET SPEEDS WHEN GAMING WITH A VPN



With all the concerns about privacy on the Internet, it is easy to make the argument for a VPN (Virtual Private Network) to keep your data encrypted and safe. The general concern among gamers is that, aside from the disadvantages of cost and complexity, a VPN can cause a speed slowdown.

In our recent Best VPN for PC Gaming Guide, none of our tested VPN services provided full download speeds. So, in the end, it becomes a balance between speed and privacy, but there are some techniques to preserve throughput, and minimize lag. There are also some less obvious advantages to gaming on a VPN, such as having access to a better server, getting around countries that block certain games, protection from DDoS attacks on the game server, and avoiding getting your online Steam account hacked and exposing your credit card data. Read the full article at http://bit.ly/2rtmyiz.

↘ submit your questions to: comments@maximumpc.com our liquid-cooled PC, with two 240mm radiators, it would never go over 50 C.

The big downside is that a custom loop needs maintaining (coolant swap every 6–12 months), and it costs more to build. Then there's human error, too….

Power of Levitation

Just wanted to post a tidbit about a great use for Corsair's new maglev fans after reading your May issue on the subject. I've got an ASRock Z97x mobo inside an Air 540 chassis, and a plethora of fans. For whatever reason, the CPU_1 and CPU_2 headers are both controlled by a single setting in the BIOS. Since I have an AIO cooler with a couple Venturi fans, I'm using the Silent profile in the BIOS. But, with all my other fans, and in the interest of tidy cables, I have to use the CPU_2 header for a couple intake fans, and here's the kicker. If I put two of my Cougar Vortex 120s or Corsair AF 120s on the _2 header, they don't spin on the Silent profile. But the new ML fans do! The reduced physical resistance seems to be enough that it doesn't overwhelm the low power on this header at this setting.

So, now my Venturis and MLs are happily spinning at ~800rpm, quiet as can be. **–Jordan Hall**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: Thanks for the tip. We've had our maglevs running as low as 400rpm, although how useful they really are at that speed is up for debate.

Bottleneck Highlight

In the Lab Notes section on pg. 92 of the April 2017 *Maximum PC*, Bo Moore mentions that the Intel Pentium G4560 gives you just enough power to not bottleneck your graphics. How do you determine that? I've been reading your mag for years, but have never figured out what to look for in order to properly pair a CPU and GPU. **–Rob Steck**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: There are no hard and fast rules, but in specific cases you can tell whether you're bottlenecked by the frame rate—once spotted, it's a case of trying different graphics cards and processors to ascertain what's holding you back. We can call on a bevy of CPUs and GPUs here that enable us to determine which games require more CPU power, and which demand more from the GPU. If there's more interest in this topic, we can look at it in a future issue, as knowing which component is holding you back is essential when looking to upgrade for a particular task or game.

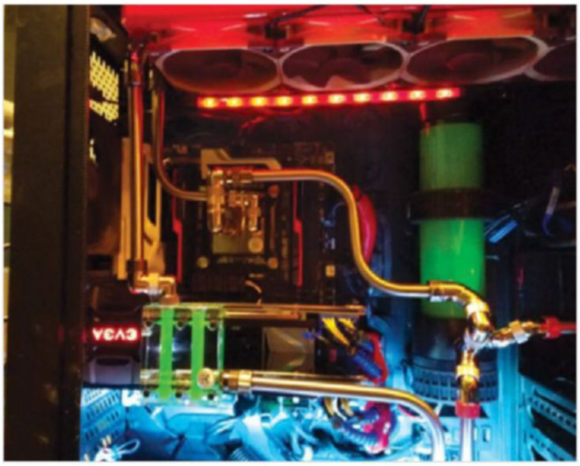
Perfect Screen

I am a heavy Photoshop and LightRoom user, and want to go 4K. That takes me down the professional monitor route. But I want to start gaming, too, so would love 4K in that world, so am studying the gaming monitors with G-Sync. I know that the gaming sweet spot is WQHD, 2560x1440, because it can be driven at 165Hz. But I need 4K for my photography. What do you suggest? **–Greg Johnson**

REVIEWS EDITOR ZAK STOREY RESPONDS: I understand what you're going through: I flit back and forth between panels. I did use a 28-inch 4K Iiyama Prolite, which was stunning, but the TN panel is less than great for color accuracy, and 4K under 32-inch is a bit hit and miss.

I've settled on a Samsung CF791. It's a superwide, 34-inch, curved, 3440x1440 display, with FreeSync, and 100Hz refresh. The best of everything in my opinion. It isn't 4K exactly, but the extra screen real estate is useful, plus the VA panel is quantum dot, with an sRGB rating of 125 percent or something incredible.

[READER SPOTLIGHT]



MILITARY GRADE

After reading about several of your builds, I decided to do my own. I built it around a Core i7-6950X and two Titans (2016), with a custom cooling loop using marine-grade (316) 0.5-inch stainless, seamless tubing, and, of course, green coolant—because why not? I went with stainless because it seems every backyard builder seems to be using clear hard tubing. I felt stainless gave the build a very different look and feel, and the acrylic GPU block/reservoir showed off enough of the green.

Here are the specs:

- *Case:* **Corsair 900D**
- *Mobo:* **Asus X99 Deluxe**
- *CPU:* **Core i7-6950X**
- *GPU:* **2x Titan Pascal (2016)**
- *Drives:* **Samsung 950 Pro 512GB, 2x 4TB WD Red (RAID 0)**
- *Memory:* **32GB Corsair Vengeance DDR4-3000**
- *Cooling:* **EKWB pump, res, and fittings, 3x Black Ice Nemesis (1x 480mm, 2x 280mm), all Noctua fans**
- *PSU:* **Be Quiet! Dark Power Pro 1,200W**

Seek 'n' Destroy

In "Recover your Data" in the Spring issue, it says, "If your hardware doesn't matter, take a hammer to your drive." It got me thinking how many old useless hard drives I have from retired builds: over 20. I found Ship'N'Shred—it couldn't be simpler: Select the range of hard drives you want to get rid of, and it sends you a pre-paid FedEx shipping label, and the cost is very reasonable. Especially when you weigh it against 60 or more hours using an eraser CD or flash drive. **–Ron Apra**

EXECUTIVE EDITOR ALAN DEXTER RESPONDS: If time is precious, a service like that is worth considering. We're big fans of destroying data ourselves here, though—often unintentionally—so it only seems fair that we take it in turns with the lump hammer ourselves. We also get on with our IT team, which means we have no end of destruction at our disposal.

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THE BUILDS

INGREDIENTS

PART			PRICE
Case	Phanteks Enthoo Evolv ITX		$70
PSU	EVGA 450B Bronze		$40
Mobo	MSI B250I PRO Mini ITX		$94
CPU	Intel Pentium G4560	**NEW**	$70
GPU	Gigabyte GeForce GTX 1050 Ti 4GB	**NEW**	$145
RAM	8GB (2x 4GB) Team Elite Plus DDR4 2400	**NEW**	$58
SSD	Kingston SSDNow UV400 120GB SATA 2.5-inch	**NEW**	$53
HDD	1TB Western Digital Green 7,200rpm	**NEW**	$45
OS	Ubuntu Desktop Linux 16.04 LTS 64-bit		$16

Approximate Price: $591

UNTIL RYZEN 3 drops, we're sticking with Intel for our budget offering. It still feels weird to say that. We saw memory creep ever higher this issue, so the budget build got a butchering. We swapped out the Pentium G4600 for a G4560, as it only loses out a touch on clock speed, and saves us a sweet $20. Next up for the chop was the 1060. We went for a slightly lower specced 1050 Ti from Gigabyte, saving $45. Although we have reservations about the 1050 Ti as an upgrade over last generation, it's still a solid 1080p GPU. Again, we decided to swap out storage, dropping the 240GB SSD for a 120GB model, enough for the OS and critical apps, while swapping to a WD 1TB Green 7,200rpm drive, which saved a substantial chunk. You could make the build even cheaper by ditching the B250i PRO ITX, and going for something like an H110. But those boards need a BIOS update (requiring a Skylake CPU) to even recognize your new chip.

INGREDIENTS

PART			PRICE
Case	NZXT S340 Elite		$100
PSU	EVGA SuperNOVA 550 G2	**NEW**	$90
Mobo	MSI X370 SLI PLUS	**NEW**	$140
CPU	AMD Ryzen 5 1400	**NEW**	$170
Cooler	Corsair H100i v2 + bracket		$105 + $5
GPU	Zotac GeForce GTX 1070 Mini	**NEW**	$350
RAM	16GB (2x 8GB) G.Skill V Series DDR4 2666	**NEW**	$104
SSD	250GB Samsung 960 Evo M.2 PCIe NVMe SSD	**NEW**	$150
HDD	Western Digital Blue Series 1TB 7,200rpm		$50
OS	Windows 10 Home 64-bit OEM		$100

Approximate Price: $1,364

RYZEN FINALLY HITS our mid-range build. We've been holding off for a while, but this combo is just right for a mid-range Ryzen system. Notable changes are the swap from the Core i5-7600K's archaic four-core design to the Ryzen 5 1400's four-core, eight-thread (think Core i7-7700K). We've also included a slight increase to memory frequency, still touting that G.Skill love, reason being that Ryzen seems to be more stable at 2,666 than 2,400. Outside of the obvious jump in processor prowess, the biggest change comes from the primary storage. Swapping out Intel's 600P M.2 PCIe SSD for a Samsung 960 Evo set us back an additional $30, but doubled our read speeds, and tripled the write speeds, for roughly the same amount of storage. One thing to note is that you have to buy the correct cooler mounting bracket for the AM4 socket separately from Corsair. You can find the link on Newegg's Corsair H100i V2 product page.

TURBO

THIS COULD BE the last time we see the turbo build in its current form. Ryzen brought multicore performance to the masses, but its life as top dog may be coming to an end. With rumors of Skylake-X and AMD's Threadripper dropping some time after Computex, we may finally see a return to HEDT platforms, with oodles of PCIe lanes, masses of cores, and hopefully some competition at the high end.

That said, we've still got to give credit to our build up top. The Ryzen 1800X is the one that started it all, and the true trooper in this build. Eight cores, 16 threads, and a handy dandy 24 PCIe lanes make this one dishy offering for any would-be streamer or workstation professional.

We did manage to make a few neat savings—amazingly, one of those is in the memory department. Swapping out from HyperX Savage DDR4 to Corsair Vengeance LED DDR4 saved us $23 for almost identically specced memory. And we got frilly LED lighting and everything. We're not a fan of RGB lighting, but crisp white lighting is ideal for anyone looking to bring attention to their tempered glass interior. On top of that, we dropped the PSU down by 100W, bringing the price down by another $10, and there's a solid deal available on a Gigabyte 1080 Ti FE, too, saving another $10. It may not be as substantial a set of changes as we've seen in the mid-range or budget systems, but it goes to show that if you search around and do some tweaking, you can refine a build, cutting costs, without sacrificing performance.

For more of our component recommendations,
visit www.maximumpc.com/best-of-the-best

INGREDIENTS

PART		PRICE
Case	Phanteks Eclipse P400S Tempered Glass Silent Edition	$90
PSU	Corsair RM750X Modular Gold **NEW**	$110
Mobo	MSI X370 Gaming Pro Carbon	$197
CPU	AMD Ryzen 7 1800X	$460
Cooler	NZXT Kraken X62 280mm AIO	$160
GPU	Gigabyte GeForce GTX 1080 Ti FE **NEW**	$690
RAM	32GB (2x 16GB) Corsair Vengeance LED DDR4 2666 **NEW**	$255
SSD	1TB Samsung 960 Pro M.2 NVMe SSD	$617
HDD	4TB WD Black 7,200rpm	$200
OS	Windows 10 Home 64-bit OEM	$100

Approximate Price: $2,879

UPGRADE OF THE MONTH

SAMSUNG 960 EVO 250GB

SAMSUNG
NVMe SSD
960 EVO
M.2
250GB

Storage is one of the most noticeable upgrades you can make to a system. Going from an HDD to an SSD for your OS is an almost euphoric experience, as long load times become a distant memory. Going from an SSD to a PCIe SSD, though? Well, that's an entirely different shift, because it becomes less about those instant boot times, and more about file transfers. Moving them across from one part of the drive is almost as satisfying as watching those boot times disappear, and Samsung's 960 Evo is a great entry point into the future of M.2 PCIe storage solutions.

$150, www.samsung.com

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